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The Benham Hydraulic Motor.

The accompanying illustrations, pages 1 and 2, show the general appearance and construction of the water motor now being introduced by the Benham Hydraulic Motor Co., of Providence, R. I.

The motor consists of eight cylinders, arranged in a fixed position, radiating from a common center, the pistons of which are connected to a common crank pin.

The flow of water to and from the eight cylinders (which are single acting) is controlled by a single brass valve (*A*, Fig. 2), which is cylindrical in form, and encircles the main crank shaft, being driven by a feather key in such a manner as to allow of sufficient end movement of the valve to enable the pressure of the entering water to keep it snugly against its seat and prevent leakage; the surfaces of the valve on which the water pressure can act, being so arranged and proportioned as to leave just sufficient unbalanced pressure to accomplish this purpose. The valve has a bearing in the nut *B*, which assists in keeping it in such a position as insures an even bearing and equal wear upon the valve seat.

The valve seat is provided with eight circular ports arranged in a circle, accurately spaced, and each communicating with its corresponding cylinder by means of the passages *l l*.

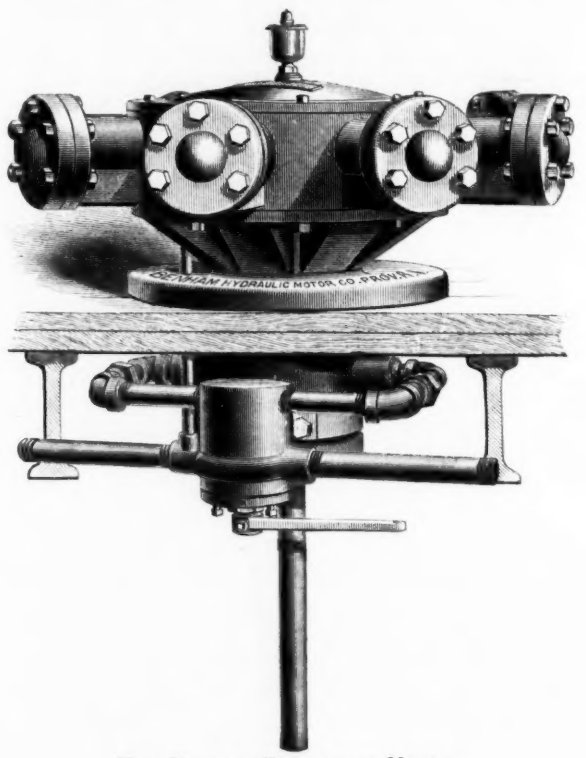
The water enters the engine through the passage *d*, and goes into the chamber *e*, around the front end of the valve, from whence it passes through an opening into the annular groove (*b*) formed in the valve.

From here it passes through the ports covered by said groove at any given time. The exhaust water passes out through the open end of the valve (*c*) into the chamber, and out through the passage *g*.

The motion of the engine is reversed by means of the reversing valve *c*. The water entering this valve through the pipe *h*, enters the chamber (*a*) around the front end of the valve, and thence into the passage (*d*) to the main valve. The exhaust water passing through the open end of the reversing valve into the chamber *j*, passes out through the pipe *k*. The reversing valve can be turned one-quarter the way round by means of the lever, which allows the water to enter the passage (*g*), and travel the reverse from above stated, thus causing the crank shaft to revolve in the other direction. This latter condition of affairs is indicated by the arrows in the sectional view, Fig. 2.

The cylinders being single acting, and open at the inner ends, piston rods are not used, but the connecting rods are attached directly to the pistons.

The manner of making the connection is shown at Figs. 3 and 4, the latter being two views of the connecting rod detached. They are made of wrought-iron, and at the crank end have a flange turned up at one side and shaped to bear against a steel sleeve lined with brass, which encircles the crank-pin. Four of these flanges are turned one way and four the other, and they are thus enabled to overlap each other on the sleeve, and ample bearing surface is secured. Outside of the flanges two steel rings are put on, which encircle them, one on each side. These rings are held in position by segments and bolts, and serve to keep all the connections in proper position.



THE BENHAM HYDRAULIC MOTOR.

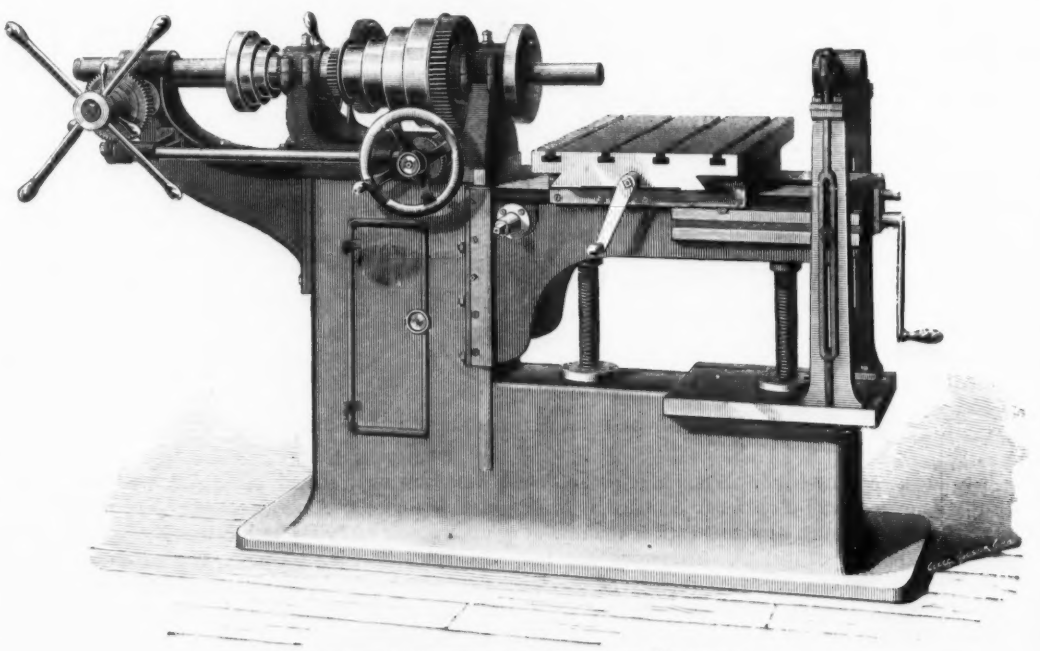
The central space, in which the crank and connections work, is kept filled with oil, so that thorough lubrication and consequent durability is assured.

These machines are suitable for any purpose for which water or other small motors are employed, and can be set with the crank-shaft horizontal, or vertical, as shown in Fig. 1.

Six of them are in use on the new dynamite cruiser, "Vesuvius," to operate the loading apparatus of the guns used on board. They will start in either direction from any position, the multiplicity of cylinders making three of them always available for starting.

They are made by the Granger Foundry and Machine Co., of Providence, for the company named above.

There is clamor in England over excessive railway charges, which puts manufacturers and merchants at a disadvantage as compared with other European countries. This, it is claimed, comes about from excessive capital outlay. It is argued that the trading public should not be made to suffer forever for this; but what the remedy is to be is not clear. Undoubtedly it is a great economic question in a manufacturing country like England, whose manufacturers and artisans are thrown in the closest kind of competition with those of other European countries where the evil complained of does not exist.



HORIZONTAL BORING AND DRILLING MACHINE.

Horizontal Boring and Drilling Machine.

The horizontal boring machine has been for a long time classed with lathes and planers as a standard tool, especially among manufacturers engaged in a heavy class of work.

The makers of the boring machine we here describe and illustrate, being unable to find one adapted for lighter or medium work, designed this machine for their own use, and, after giving it a thorough trial, decided to manufacture them for the market.

The table is 20x36 inches. It has a cross movement of 30 inches, a lateral movement of 28 inches, and a vertical movement of 16 inches. The latter is effected by a crank either at the end or at the side of knee near the hand wheel. The two elevating screws are geared together, and provided with an adjustment by which the table can be kept parallel with the spindle.

The spindle is 2¼ inches in diameter, and will feed 14 inches. It has automatic feed, and also slow and quick hand feeds. The slow hand feed is worked by means of the wheel at the left of the knee, and made automatic by turning the friction knob, quick motion being given by the handles at the extreme left. The front end of the spindle has a taper hole to receive boring bars, collets and drills.

The back rest is movable on the bed, and can be rigidly bolted to the same, also to the knee after being placed in position. The top of the rest is detachable, a feature which has proved a great convenience.

The machine is back-geared, carrying a 2½ inch belt, has eight changes of speed, and is furnished with a double-friction countershaft.

Warner & Swasey, of Cleveland, Ohio, are the designers and makers.

A correspondent writes us, in reference to the experimental steel works at Springfield, Ohio: The steel-making works recently established in Springfield, Ohio, are completed, and have been put in operation. The steel is made by the pneumatic process; the blast is admitted at the side instead of at the bottom of the converter. If the converter is turned so that the tuyere is below the surface of the metal the blast blows through it, entering through five tubes 1¼" in diameter, at a pressure sufficient to keep them clear of melted metal. In this half a ton of iron is converted into steel in eight minutes. As in other processes, the quality of the product depends upon the materials used.

The reports show that on English railways the receipts for freight traffic are not only larger in the aggregate, but larger in proportion to capital invested, than from passenger traffic.

The Ninth Annual Meeting of the American Society of Mechanical Engineers.

The opening session of the ninth annual meeting of the American Society of Mechanical Engineers was held at the hall of the Y. M. C. A., at Scranton, Pa., October 15, at 8 P. M. Col. J. A. Price, for the Mayor, delivered the address of welcome.

In reply, C. J. H. Woodbury, vice-president of the Society, said :

The American Society of Mechanical Engineers, in acceptance of the invitation to hold their eighteenth meeting at Scranton, are assembled for the fourth time in the State of Pennsylvania.

It has always been a pleasure to receive the hospitality of your good folk, and in a professional sense highly profitable to meet in the Keystone State, for its temperate climate and fertile soil produce an abundance of varied food ; its picturesque mountain ranges abound in stores of ore, limestone, coal and oil ; the skill of the people in your factories puts forth a wide range of textile, paper and metal products ; the whole commonwealth forming an harmonious environment for the development of the highest types of engineering skill.

A meeting like this forms rare opportunities for the greeting of old friends and the forming of new acquaintances, but the paramount motive is the hope of learning from others.

We are here because we realize our ignorance.

The onward progress of engineering is keeping pace with the advance of civilization like a bird on the wing.

Individual experience is limited, the books are necessarily behind the times, and it is at these meetings that we expect to receive the truths of to-day engineering.

I would be the last to cast any general reflection on the value of organized mathematical principles, which are expressed in formulæ, but it should be remembered that every formula must contain a constant before it can be applied, and that constant means simply facts.

Facts are fugitive things, eluding all except the most persistent; and this meeting, whether in the sessions devoted to papers and discussions, or in the excursions to some of your engineering works, will all be devoted to facts.

The great apostle boasted that he was a citizen of no mean city, and your municipality is known over the country for its enterprise, skill, and business integrity.

It would be invidious to make distinctions, but we all know how the late Moses Taylor, with wisdom to plan and vigor to execute, gave industries here the benefit of his capital and financial experience ; and in this connection a passing reference is due to William Scranton, of your city, as a pioneer in the introduction of new machinery, and improved methods of steel manufacture.

For the second time in the history of this organization, illness of a president has imposed active duties upon a vice-president. You all join with me in expressions of sympathy for President See, and rejoice in the news of more favorable symptoms. Personally I ask for your indulgence during the coming sessions.

The balloting for officers for the ensuing term resulted in electing the following : For President, Henry R. Towne, Stamford, Conn.; Vice-Presidents, William Kent, New York City; Thos. J. Borden, Fall River, Mass.; Charles B. Richards, New Haven, Conn. For Treasurer, William H. Wiley, New York City. For Managers, Frank H. Ball, Erie, Pa., William Forsyth, Aurora Ill., George M. Bond, Hartford, Conn.

The *Electrical Review* has an account of an experiment which was tried to demonstrate the feasibility of locating the bullet in President Garfield's body by aid of the electric light. It is a familiar fact, that when the hand is held before a light of even ordinary power, it seems to shine through the fingers and illuminate them.

It was reasoned from this that if a light of sufficient intensity could be concentrated upon the part of the president's body where the ball was supposed to lie, it might penetrate the body and reveal the exact location. A ten-light dynamo was arranged to make a single light between a pair of carbons which were regulated by hand. A manufacturer of locomotive head-lights made a reflector with a curvature such as to concentrate the rays at a point ten feet distant. The work was hastened day and night as rapidly as possible, and when ready it was thought best to give the matter a practical test, in order to be able to remove any possible skepticism on the part of physicians. A veteran was found who carried a bullet in the small of the back, and who readily consented to have the apparatus tried upon him. The man and the apparatus were placed in position, but when the dynamo current was turned on it was found that not only a strong light was concentrated at the spot, but also sufficient heat to sear the flesh, which it did very quickly ; and the project was abandoned.

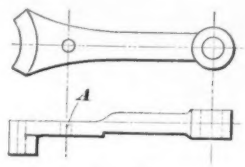


FIG. 4.

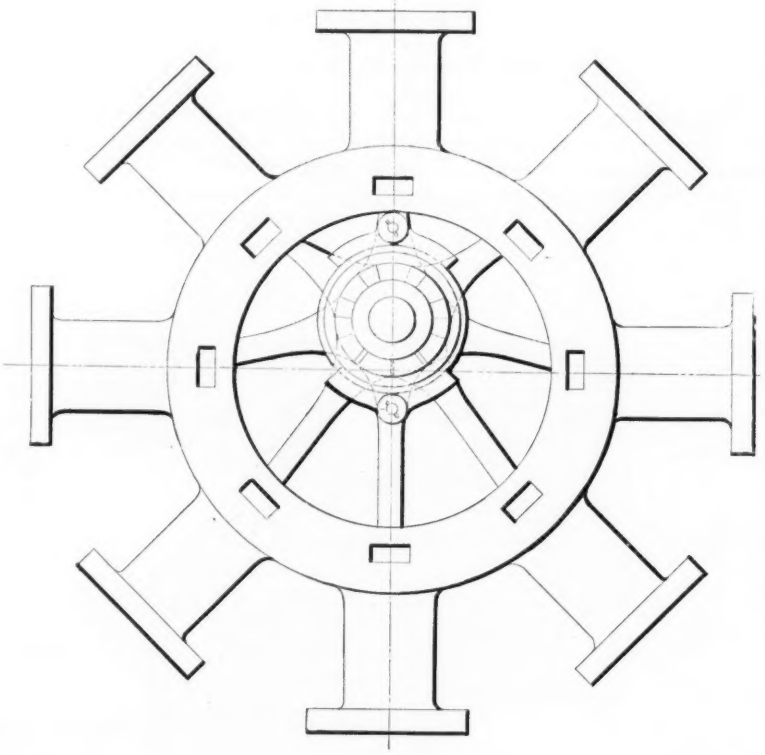


FIG 3.

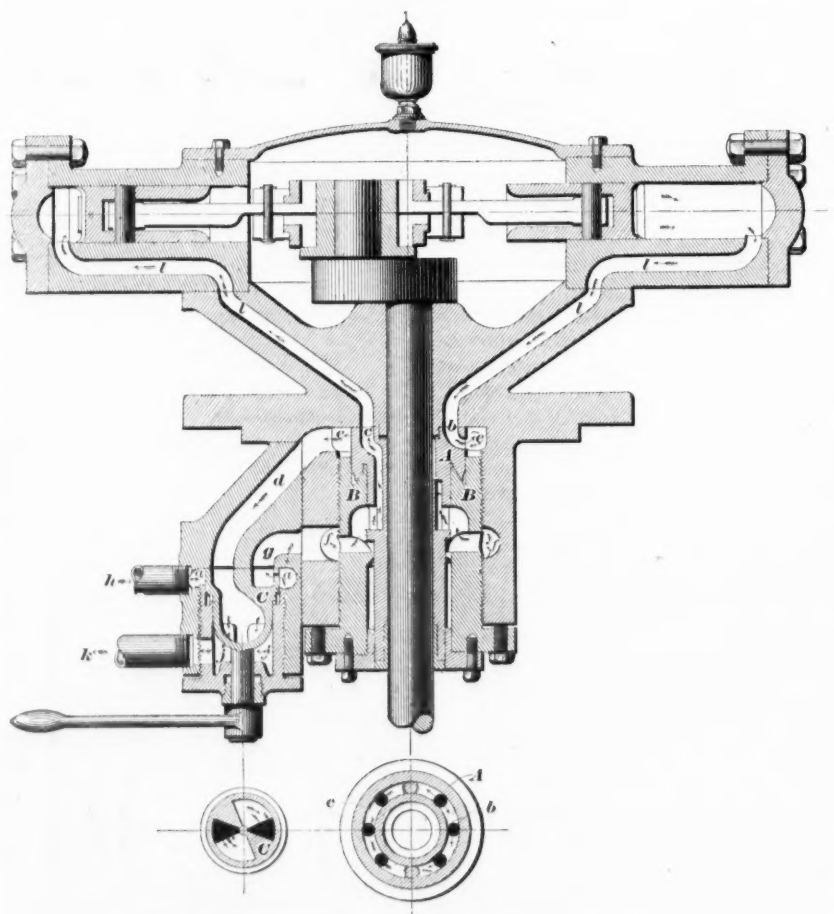


FIG. 2.—THE BENHAM HYDRAULIC MOTOR.—SEE PAGE 1.

English and American Locomotive Construction.

BY W. H. BOOTH.

SEVENTH PAPER.

Practically, the only difference between the American and English standard types of tender is that the American tender is carried upon a pair of four-wheeled trucks, and the English tender is a plain six-wheeled vehicle, the middle wheels being fitted with blank tires. There are no other material differences.

Despite the original lateral flexibility of the plate frame, this has now been much modified, and the plate frame, as made, cannot be very flexible, for to its upper edge is firmly attached the broad foot-plate, which effectually stiffens the frame from end to end; for, though the wheels project through the foot-plate, and stop the continuity of its connection to the frames, the connection exists between the two wheels.

In freight engines the English type is very different from the American, and it is of interest to note that whilst in England the variety of passenger locomotives is very great, there is practically but one type of freight engine, whilst in America the passenger engine may be said to be represented by one standard type, and the freight engine by many—the reverse of English practice. The standard English freight or goods engine is a six-wheel machine, all coupled on a rigid wheel base. The cylinders are inside the smoke-box, and the main rods take hold of the middle axle, which of course is cranked. No trucks are used or required, and the wheel diameter is 5 feet. Fast goods trains do not exceed forty miles per hour, and ordinary trains are much slower. The call for speedy delivery, however, has brought about a service much lighter and quicker than known in America, and the English freight engine is not specially heavy or powerful, having at most 18-inch cylinders, and a boiler 10 ft. 6 x 52 inches. On one line, the Great Eastern, some engines of the Mogul type are in use, but this instance is quite exceptional, and with the crowded lines of the country it does not seem probable that a slow and heavy freight service could be well worked in. Only one species of traffic in England would really warrant such long trains, and that is the coal trade to London from the pits of Yorkshire. There is no other similar traffic of raw rough material for any long distance—a fact, the significance of which entirely escaped Mr. Dorsey in writing his comparisons of English and American railroads.

The cylinders of the goods engine are inclined and raised to an extent sufficient to allow the guide bars to clear the leading axle. The inclination of cylinders is less harmful than in the case of a high-speed passenger engine—indeed, is not found to be in any way a difficulty. Freight engines are frequently employed to run passenger trains, especially when long and heavy, as during the excursion season, on account of their higher tractive effort.

I have thus far indicated the general differences between American and English practice, and shown the reasons for such differences, from which it will be seen how slight these really are, and how also they are almost wholly due to reasons connected either with climate or the different construction of the railroads. There are no other reasons than these, nothing in the mechanical practice of the two countries, which should cause such variations. Indeed, this is evident on a comparison of stationary engine practice. Here, where the engine is covered by a roof, and climate cannot step in, we find very little difference indeed between an English and an American made machine. I trust that what I have written may help to modify the views of some of the contestants on both sides of the controversy on the respective merits of the two types of construction, each of which is best in its own country.

I will now touch on the differences in working, which are brought about by differences of construction. I have already noted that the more rapid motion of the piston is a partial reason for increased size of steam pipes in American practice. For the remainder of the difference I confess I see no very clear reason. A high speed of revolution demands an earlier point of cut-off, with its attendant earlier lead, because of the difficulty which exists with ports and passages of reasonable area in getting rid of the steam. It is well known that most valve motions give also at early cut-off a very seriously increased compression. Consequently, we should expect that the mean area of the indicator diagram from a locomotive at high speed would be less than from the same engine at even the same cut-off but at a lower rate of speed. For equal forward velocities we already know that for equal cylinders and mean pressures on piston the locomotive with the smallest wheel will have the greatest tractive force, and should, therefore, expect American engines to be capable of drawing heavier loads than the larger wheeled English

locomotive. At slow speeds such is no doubt the fact, but at high speeds the effect of the imperfections of valve gearing, and the necessity of moderation in design of ports, etc., renders it possible not merely to obtain larger diagrams from an equal cut-off, but to use a later cut-off, simply because of the slower speeds of piston in engines with large wheels, and so the supposed disadvantage of the large wheel disappears, and it is at a disadvantage only at starting. To such an extent is the locomotive a compromise as regards so many of its parts and dimensions, that it is difficult to alter any one dimension to advantage without the introduction of some countervailing disadvantage, and this explains why so nearly equal results may be obtained from such a variety of designs. Locomotive engineering is so largely a question of averages that it is quite legitimate to argue on a basis of averages, and it may be taken as granted that the average adhesion of wheel and rail is higher in America than in England, where the climate is more humid, and extended periods of dry weather are rare. The direct result of this higher co-efficient of adhesion is, of course, the power to utilize at starting the higher tractive force of the smaller wheel, and it is clear that, even with smaller wheels, the increase of traction might in England be useless, in face of lack of adhesion. Now whilst, at starting, the tractive force of a locomotive is so frequently able to overcome the adhesion at the rail, it is by no means able to do so at high speeds, and the adhesion of a single pair of wheels is more than enough to transmit all the tractive force which an engine can develop. This is the one great argument in favor of the single pair of drivers, for it is urged with reason, "Why hustle round hundreds of miles with a power-absorbing, friction-making coupling rod, for the sake of a few yards at starting, when the single wheel has deficient adhesion only." Clearly it is wrong to do so, and now that improved methods of blowing a spray of dry sand directly between wheel and rail are known and satisfactorily working, the single engine is daily growing in favor in England for the fastest traffic, and ought to be at least fairly tried in America, where certainly it should be at least as efficient as in England, on account of the greater average co-efficient of adhesion which obtains—an advantage due to natural causes which is entirely thrown away. We see, therefore, that the large wheel of English engines is, whether intentionally or otherwise, a means to overcome some of the defects of the link motion valve gear, and hence is not actually a cause of reduced traction, whatever it may appear when not considered with the teaching of the indicator.

For early cut-off present valve motions are unsuitable, but nothing yet seems to have been devised which overcomes all its faults. When such a gear is found, much of what we have written on wheel diameters will, perhaps, require some modification. Indeed, as a single evidence of the objection to coupling rods, and the tendency of improved valve gear to remove the advantage from the large wheel, we might instance the compound engines of Mr. Webb, in which, while coupling rods and all their attendant friction and loss of power are abolished, yet the tractive force is still distributed through four wheels. To certain practical difficulties of this novel system we have already referred sufficiently under the head of compound engines, and here for the present we leave the subject.

Discovering Leaks in Ships.

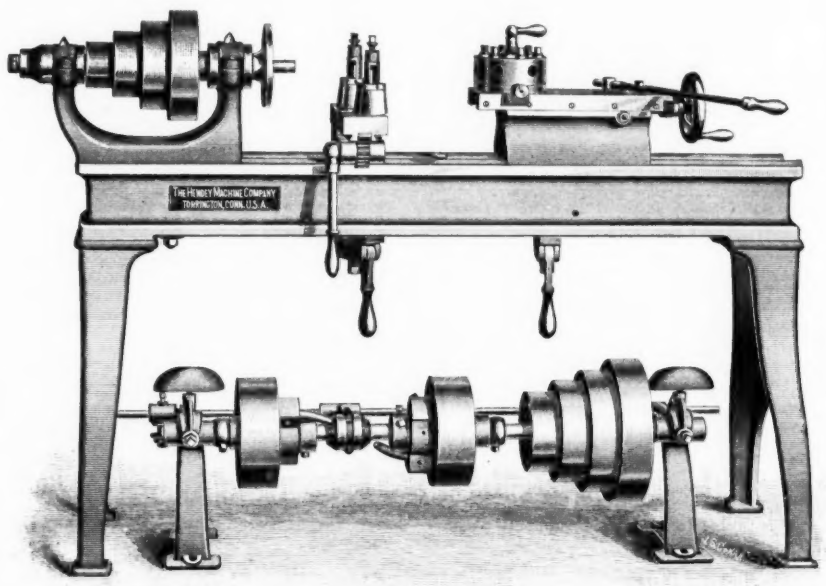
A Norwegian engineer, Herr Th. Thorbjörnsen, of Kragerö, has constructed an apparatus for discovering leaks in ships. The apparatus is very simple, consisting of a closed furnace, which is placed on the deck of the vessel, and in which smoke is produced by burning straw or bramble. The hatches having been closed, the smoke is forced into the hold by means of a blower and a tube, and in the course of half an hour or an hour the smoke will escape through any leaks there may be in the vessel's sides or bottom. Of course the vessel must be in a dry dock. At a recent experiment at Gothenburg, a leakage which had previously defied detection was discovered in half an hour by the help of the apparatus. The time generally occupied in discovering a leak is estimated at from thirty to forty minutes in a vessel of 500 tons, and the cost of the experiment at 4d. per ton.—*Iron* (London.)

During the recent railway racing to Edinburgh and Glasgow, the Northeastern Company made no change in their engines; the regular engines that had been on the Scotch service were used all the time, and in nearly all cases these were compound engines. They had a pretty heavy train throughout, and well filled with passengers and luggage. On the last day of the accelerated running, they ran into Edinburgh 34 minutes before time; the run was done from Newcastle to Edinburgh—125 miles—in 128 minutes by compound engine No. 117. This is at the rate of 58.6 miles for the whole run, and beats the whole record.—*The Engineer* (London).

15-Inch Turret Lathe.

We illustrate herewith a tool intended to answer the purpose of the more expensive screw machine on certain lines of work.

The foot-block is provided with a turret, having six holes, which is rotated by hand by withdrawing the stop-pin at the side. The turret slide can be moved by the lever shown,



15-Inch Turret Lathe.

or, by removing this lever, drawing the slide back as far as possible and tightening the nut on the side of the foot-block; the hand wheel can be used for operating the slide. It then becomes, in effect, a complete hand or speed lathe.

The cut-off slide has two tool posts, with adjusting stops for each. The spindle has a $\frac{5}{8}$" hole through its entire length, and a Morse taper hole for center. The boxes are of deoxidized bronze. The spindle is furnished with a face-plate, as shown in cut, but chucks of any make will be fitted if desired. The lathe swings 15 inches, has a 5-foot bed, and weighs 700 pounds. It is made by the Hendey Machine Co., Torrington, Conn.

Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

By W. H. Hoffman.

SEVENTEENTH PAPER.

In this paper I will continue the description of the steam cylinders already begun in the twelfth paper. It was then stated that a steam cylinder with a diameter of 50", and under a pressure of 170 lbs. per square inch by gauge, need not be more than $1\frac{1}{2}$" thick, if it is properly reinforced by outside strengthening ribs $1\frac{1}{2}$" thick and $2\frac{1}{2}$" deep, these ribs being cast to the body of the cylinder.

As it is proposed to give all the piston valves a uniform ultimate travel, we shall be able (owing to the width of the ports) to reduce the diameter of the piston valves below the usual standard. The valves will be of a new design, and will be described in detail in another paper, but I will here give the diameter of each valve, and the ultimate travel of all of them. According to the proportions for cylinder ports, given in the fifteenth paper, the high-pressure cylinder ports must each have an area of 40 square inches, the intermediate cylinder ports 97 square inches, and the combined low-pressure cylinder ports 330 square inches. In speaking of these ports, I refer to the steam openings in the piston valve seat, or casing, leading to the end ports of the cylinders.

To arrive at the common travel for all the valves, let us first fix on the proper dimensions for the two low-pressure valves. The main object is to reduce the size of the average marine piston valve, and I will here say that, although we shall have four port bridges, at *each* port on each valve casing, we shall find that by introducing the double system, or two complete piston valves on the 68" low-pressure cylinder, we can get the full area by making each of these valves 19" diameter, with a width of port of $3\frac{1}{4}$".

As previously stated, the valves will be of equal travel, and consequently all the steam ports in the cylindrical valve seats will be $3\frac{1}{4}$" wide, while the full travel of the valve, adding the outside lap, will be $10\frac{3}{4}$".

As the intermediate cylinder ports must have an area of 97 square inches, the piston valve for this cylinder will be $12\frac{1}{2}$" diameter, and again, as the high-pressure valve port must have an area of 40 square inches, I shall fix the diameter of this piston valve at $7\frac{7}{8}$"; the increase in proportion being due to its having the same size valve stem as the other larger valves. It will be seen by the above figures that our valve chests will be comparatively small, especially those of the intermediate and low-pressure cylinders. The port areas given are ample for a piston speed of 750 feet per minute, and the space around the piston valve casings, or seats, will in all cases be fully equal to the port areas, so that there can be no wire-drawing in these passages.

In constructing the steam cylinders, we will adopt the following system, as to the inside linings and the steam jacketing. The high-pressure cylinder will, owing to the high temperature of the steam, be lined with a close-grained cast-iron liner, $1\frac{5}{8}$" thick at the main bore, and $1\frac{1}{8}$" thick at the counter-bore. This liner will be pressed into place by moderate screw or hydraulic pressure, and will have a flange joint $2\frac{1}{4}$" wide at the top end, and a copper ring joint at the lower end; the ring joint being of the cup form, and sectional, to allow for the varying expansion of the liners and cylinders' bodies.

The top cylinder head joint will be made on the flange of the liner, and consequently the liner will receive the pressure of all the top cylinder head bolts, to keep it in position, while the copper rings will be held in a groove turned in the lower cylinder head.

The live steam jacket for the high-pressure cylinder will be formed by space of $1\frac{1}{8}$" wide, that will be left between the liner and the main body of the cylinder. The main body of this cylinder will be 1" thick, reinforced by three circular ribs extending around the body of the cylinder and valve chests; the ribs being 1" thick and $2\frac{1}{4}$" deep. To these ribs on this cylinder will be fastened the wooden lagging; the ribs to be reduced in depth to $1\frac{3}{4}$" where they pass around the body of the valve chests.

The intermediate cylinder will have its lining and cylinder body cast in one piece; in other words, the jackets will be cast onto the cylinder, allowance for expansion being made by casting two semi-circular corrugations equidistant between the ends of the cylinder, the inside radius for the corrugations being $2\frac{1}{4}$", and the thickness of metal at this point $\frac{3}{8}$ of an inch. The thickness of the jacket, other than at the point of the corrugations, will be $1\frac{1}{16}$", and the thickness of the inside, or what I will designate as the liner portion of this cylinder, will be $1\frac{5}{8}$" at the main bore, and $1\frac{3}{8}$" at the counter bore, but it must be understood that this portion of the cylinder is not reinforced.

In order to insure a sound casting we must have some body to the spacing core, that will be placed between the inner portion of the cylinder and the jacket; consequently this jacket space in the casting cannot be less than $2\frac{1}{2}$" in the clear. On the outside of the jacket there will be one central rib, $1\frac{1}{2}$" thick, and the same depth as the corrugations, and to this rib, as well as the two corrugations and cylinder flanges, will be fastened the wooden lagging.

The 68" low-pressure cylinder will be cast on the single-tube plan. There will be no liner, and no cast-iron jacket, as the jacketing in this case will be accomplished by enveloping the plain cylindrical portion of the cylinder in a plate steel jacket $\frac{3}{8}$ of an inch thick.

The pressure in this jacket will be reduced to 80 lbs. per square inch by a reducing valve, in order to prevent the waste of heat that would pass through the walls of the cylinder directly to the condenser, and from thence be carried off with the circulating water, as would be the case if live steam at 170 lbs.' pressure was allowed to enter the jacket.

The high and intermediate cylinder jackets, however, will receive steam direct from the boiler at gauge pressure, and all jackets will be drained to a common hot water well, connected with feed pumps. The plate steel jacket will be riveted to angle flanges at each end of the cylinder, the rivets being on the *outside* of the jacket, thus making the riveting an easy task.

The cast-iron body of the cylinder will be $1\frac{3}{8}$" thick at the main bore, and $1\frac{1}{2}$" thick at the counter bore. To reinforce this cylinder there will be four reinforcing ribs cast onto the body, $1\frac{3}{4}$" thick and $2\frac{1}{4}$" deep, this depth allowing a circulating space between the edges of the ribs and the inside of the steel jacket. The edges of the steel plate will be prepared for calking by a "Connery" planing tool. The rivets will be spaced in single rows at each end of the cylinder, $2\frac{1}{8}$" from center to center, and the holes for the rivets in the plate will be drilled. This system of plate-jacketing was used by the writer with success, and described by him in the American Machinist, about eight years ago.

The wooden lagging on this cylinder will clear the steel plate jacket $\frac{3}{4}$ of an inch, and will be fastened to the main cylinder by segment rings, made of light angle iron, which in turn will be fastened to the cylinder by $\frac{1}{2}$" machine screws.

In a city not far from New York the tax rate is very nearly 3 per cent.—to be exact, 2.98 per cent. This is a big handicap to manufacturers, and when a poor man pays that rate on his little house he is almost inclined to wish he owned no real estate. Such cases of municipal recklessness are by no means uncommon in this country, and they seriously injure the prosperity of the cities in which they occur. It would, in such cases, be an excellent thing for the citizens to sound a truce in politics, and vote for honest men for a few years.

Practical Drawing.

By J. G. A. Meyer.

SIXTY-SECOND PAPER.

505. *Practical application of Problem 73.* In Problem 73 we have found the intersection of a plane with a cylindrical surface; the method there given for finding the curve of intersection is applicable to many practical problems. For instance, Fig. 389 represents a longitudinal section of a locomotive extension smoke-box. The plate $A\ B$ is the upper, and the plate $F\ G$ the lower diaphragm plate, both of which extend across the smoke box. $C\ D$ represents a netting extending across the smoke-box and rigidly fastened to the latter. $D\ E$ represents another portion of the netting, also extending across the smoke-box; this part of the netting swings on the hinges H, like a door, and is held in position by a key through the stud K. Fig. 390 represents one-half of the end view of the smoke-box. The space between the two inner semi-circumferences represents the flange $R\ R_2$ (see Fig. 389) of the flue sheet; the space between the second and third semi-circumferences represents the end view of the boiler course $T\ T_2$ (see Fig. 389); and the space between the two outer semi-circumferences represents the end view of the smoke-box sheet $S\ S_2$ (Fig. 389). In Fig. 390 the lines $I_1\ F_1\ I_6\ D_6$ and the arc $I_1\ I_6$ are the boundary lines of one-half of the lower diaphragm plate; and since the line $F\ G$ in Fig. 389 and the plane $I_1\ F_1\ I_6\ D_6$ in Fig. 390 represent one and the same surface, it follows that the point F and the line $I_1\ F_1$ must lie in one and the same horizontal line; and for a similar reason the point G (Fig. 389) and the line $I_6\ D_6$ (Fig. 390) must also lie in one horizontal line. Again, in Fig. 390 we can only see the edge of the upper diaphragm plate, the line $I_1\ F_1$ representing its lower surface, and the parallel line above, the upper surface of the same plate; the netting, of course, extends from the latter line to the semi-circumference which represents the inner surface of the smoke-box. The two outer semi-circumferences are drawn in full, because there is nothing in front to hide them; a large portion of the two inner ones is dotted, because that portion is hidden by the netting and diaphragm plates.

In all first-class locomotive works the diaphragm plates and netting are cut to the correct shape before they are placed in the smoke-box; here then the question will arise: How shall we proceed to lay out these plates and netting? or in other words: How can we find their correct boundary lines?

To find the boundary lines of the upper diaphragm plate $A\ B$, Fig. 389, is a simple and an easy matter, and had it not been for one fact, which may be overlooked by some mechanics, as we shall soon point out, an explanation of the method used for laying out this plate would hardly be necessary. Although the ends of this plate should fit the sides of the smoke-box, it is not necessary that there should be a steam or air-tight joint, neither is it necessary that the edges of both the upper and lower surfaces of the plate should touch the sides of the smoke-box. These plates are sheared off square, and therefore, to save as much chipping and fitting as possible, we lay out the sheet, so that only the edges of the upper surface of the plate will touch the smoke-box.

At any convenient distance above the sectional view of the smoke-box, draw a horizontal line $A_2\ D_2$. Through the ends A and B, and also through the points a_{10}, a_{11}, in which the upper surface of the plate intersects the edges $R\ R_2$ and $T\ T_2$, draw vertical lines cutting the horizontal line $A_2\ D_2$ in the points A_2, B_2, a_4 and a_6 respectively, and let the vertical lines extend a short distance above the line $A_2\ D_2$. On the line $A_2\ a_8$, from the point A_2, lay off a point a_8; the distance between these points must be equal to the horizontal distance between the center line $x\ y$ (Fig. 390) and the point a_8, in which the upper surface of the plate cuts the semi-circumference marked 1. From the point a_4 on the line $a_4\ a_5$ lay off a point a_5; the distance between these points must be equal to the horizontal distance between the center line $x\ y$ and the point a_9, in which the upper surface of the plate cuts the semi-circumference marked 2. And lastly, from the point a_6 on the line $a_6\ a_7$ lay off a point a_7; the distance between these two points must be equal to the horizontal distance between the center line $x\ y$ (Fig. 390) and the point in which the upper surface of the plate cuts the semi-circumference marked 3. Through the points a_8, a_5, a_7 draw horizontal lines as shown. Then the lines $a_8\ b$, $b\ a_5$, $a_5\ c$, $c\ a_7$, $a_7\ b_2$, $b_2\ B_2$ and $A_2\ B_2$ will be the lines to which the plate must be cut. The fact which may be overlooked, is that the depth $a_5\ b$ of the first notch (Fig. 389 *A*) must be greater than the thickness of the flange of the flue sheet; and the depth $a_7\ c$ of the second notch must be greater than the thickness of the boiler course T; because the higher the diaphragm plate $A\ B$ is placed in the smoke box, the greater will be the differences in the lengths of the lines $A_2\ a_8$, $a_4\ a_5$, $a_6\ a_7$.

In finding the boundary lines for this plate, we have assumed that there are no rivet heads in the way. The lines $C_2\ c_3$, $c_3\ d_3$, $d_3\ D_2$ and $C_2\ D_2$, Fig. 389 *A*, represent the outline of the netting; and since only the upper surface of the netting is to fit the sides of the smoke-box, the width $D_2\ d_3$ must be less than that of $B_2\ b_3$ of the diaphragm plate, because the netting is placed above the plate.

In laying out the lower diaphragm plate $F\ G$, let us assume that only its outer surface $F\ G$ is to fit the sides of the smoke-box. Divide the line $F\ G$, Fig. 389, into any number of equal parts, say five, and mark the points of division d_2, d_3, d_4 and d_5. Through these points of division draw horizontal lines cutting the semi-circumference marked 3 (Fig. 390) in the points I_2, I_3, I_4, I_5 and also cutting the center line $x\ y$ in the points D_2, D_3, D_4, D_5. Also through the ends F and G, and through the points d_2, d_3, d_4, d_5, draw lines perpendicular to $F\ G$; and at any convenient distance from $F\ G$ draw a line $f_1\ f_6$ parallel to $F\ G$, cutting the lines perpendicular to it in the points f_1, f_2, f_3, f_4, f_5 and f_6. On the line $f_1\ F$, lay off a point i_1; the distance between points f_1 and i_1 must be equal to the length of the line $I,\ F$, in Fig. 390; on the line $f_2\ d_2$ lay off a point i_2; the distance between the points f_2 and i_2 must be equal to the length of the line $I_2\ D_2$. In a similar manner make the line $f_3\ i_3$ equal to $I_3\ D_3$; $f_4\ i_4$ equal to $I_4\ D_4$; $f_5\ i_5$ equal $I_5\ D_5$; and $f_6\ i_6$ equal to $I_6\ D_6$. Join the points i_1, i_2, i_3, i_4, i_5 and i_6 by a curve; the lines $f_1\ i_1$, $f_6\ i_6$, $f_1\ f_6$ and the curve will be the boundary lines of one-half of the lower diaphragm plate; the other half of the plate will, of course, have to be cut to the same dimensions.

To find the shape of the netting $D\ E$, Fig. 389, we proceed in the following manner: At any convenient distance from $E\ D$ draw a line $l_1\ l_6$ parallel to the former. Divide $D\ E$ into any number of equal parts, say five, and mark the points of division $n_2\ n_3$, $n_4\ n_5$. Through these points of division, and also through the extremities D and E draw lines perpendicular to $D\ E$, cutting the line $l_1\ l_6$ in the points l, l_2, l_3, etc. Again, through the points of division n_2, n_3, etc., draw horizontal lines cutting the semi circumference marked 3 (Fig. 390) in the points M_2, M_3, etc., and also cutting the center line $x\ y$ in the points N_2, N_3, etc. Now make $l_2\ m_2$ (Fig. 389 *C*), equal $N_2\ M_2$ (Fig. 390); $l_3\ m_3$ equal to $N_3\ M_3$; $l_4\ m_4$ equal to $N_4\ M_4$, and so on. Join the points l_1, m_2, m_3, etc., by a curve. In a manner precisely similar to the foregoing, find points in, and draw the curve $l_1\ m_7$ on the other side of the line $l_1\ l_6$. The netting will then have to be cut to the curve $m_7\ l_1\ m_6$ and the straight line $m_7\ m_6$.

Comparing the method employed for finding the shape of the netting as shown in Fig. 389 *C*, and also the method employed for finding the outline of the lower diaphragm plate, Fig. 389 *B*, with the method given in Problem 73, for finding the curve intersection shown in Fig. 376 (59th paper), it will be seen that these methods are identical. In Problem 73 we had to deal with geometrical solids; in our present problem we have to deal with mechanical objects; yet the principles involved in the solution of our practical problem are the same as those established in the theoretical problem.

Directions.—On one of the smaller sheets (15″ x 20″), draw a longitudinal section of an extension smoke-box, as shown in Fig. 389. Then find the true form of the diaphragm plates and netting, according to the method given in our problem; use 1½ inch scale.

Note.—The different views of the smoke-box etc., given in connection with this problem, are all connected. This was done to show clearly the principles of the method employed in finding the required outlines. When work of this character has to be laid out in the boiler shop, the method here given is in no wise changed, yet the number of lines will be considerably less, as will be shown in our next paper.

It should also be noticed that in the foregoing problem we have had to deal with comparatively rough work, and consequently we have laid out the diaphragm plates and netting so as to make only one of their surfaces touch the sides of the smoke-box. In practice we often meet with cases of similar character, but in which a more perfect contact between the objects is required. An example of such will be also given.

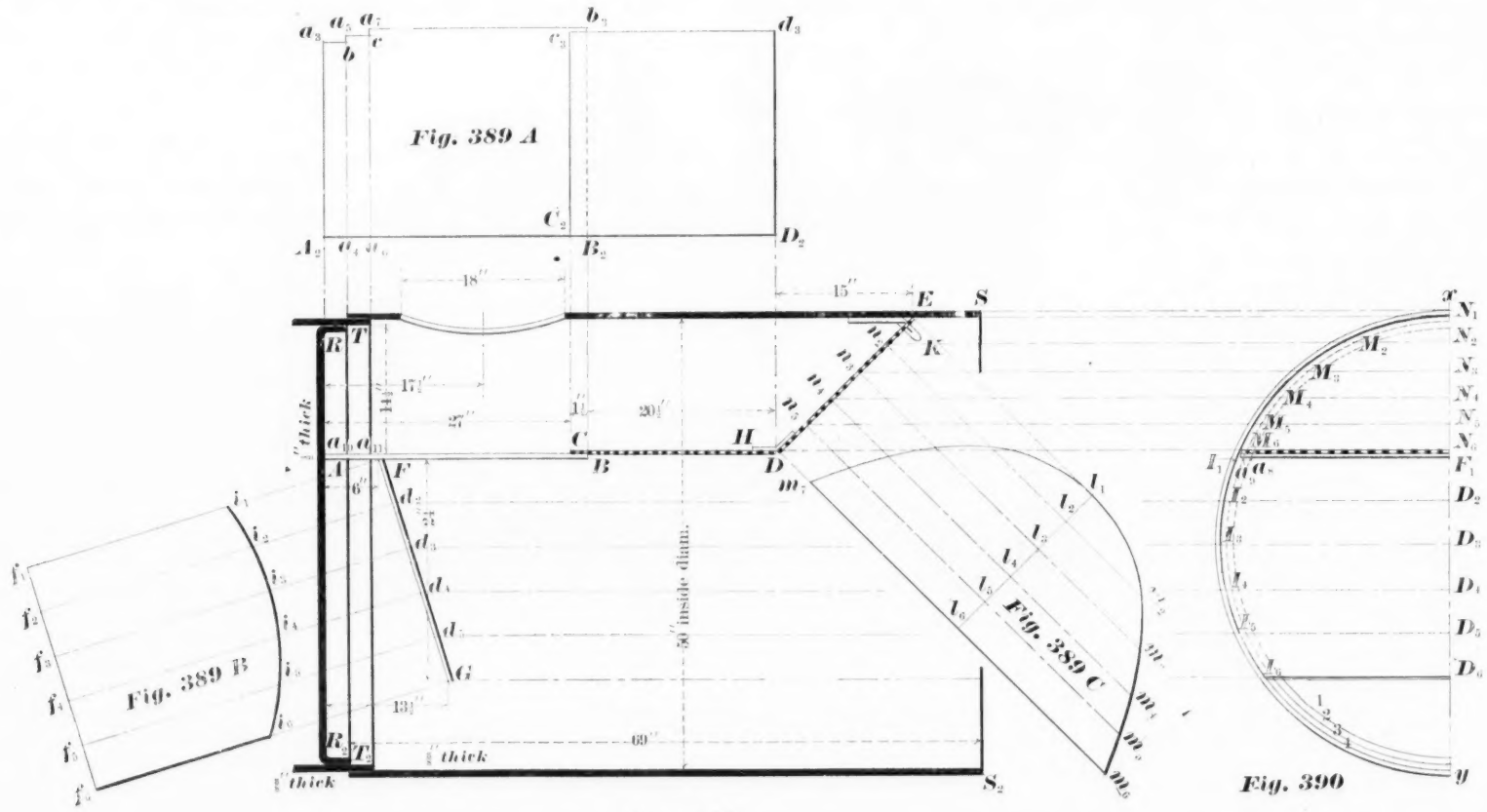


Fig. 389

A serious and quite unprecedented misfortune has happened to the sloop Nymphe, which is completing for commission at Portsmouth. The vessel, which was laid down in July of last year, was only floated out of dock a few months ago. At the time the water was admitted, the after and upper portions of the hull, as well as the rudder, were coppered, the ends of the propeller shafts to which the twin screws are fitted being covered with paint to prevent their rusting. When, on Wednesday, the water was pumped out of No. 1 dock, whither the sloop had been taken to be prepared for her steam trials, by the Greenock Foundry Company, an alarming state of things was discovered. While she was in the ship basin the water seems to have percolated through the composition, and set up a powerful galvanic battery between the copper and the steel. As a re

sult, the exposed parts of the propeller shafting are seriously damaged, ruts an inch broad having been eaten out of the steel in some places as though gouged with a chisel. The key pieces are bitten away at the sides while deep holes are everywhere visible. The propeller shafts are 45 feet long, manufactured out of a single ingot, and the injury is so great that new ones will probably have to be fitted. Where the nuts screwed into the ends the threads are in a state of perfect preservation, and had the usual precaution of covering the exposed surfaces with zinc caps been followed no harm would have been sustained.—*Engineering.*

Force in the Steam Engine, and its Relation to Smooth Running.

BY PROF. JOSEPH E. TORREY.

THIRD PAPER.

In the two previous papers I have confined myself to the consideration of the steam forces as we find them operating in the steam engine, and if we could assume certain impossible conditions, that would be the "conclusion of the whole matter." But, unfortunately, we are confronted at the outset by certain conditions and facts which render the investigations thus far considered, by themselves, worthless. In the first place, we have rectilinear (or straight line) motions in case of the piston and rod, crosshead, etc., which must be transformed into rotary motion at the fly-wheel. Thus far nothing has done the work better than the ordinary crank, and although there may be a slight loss of power by this arrangement, it is doubtful if anything will ever replace it. In the second place, the reciprocating parts (piston, crosshead, etc., etc.,) possess weight. This second fact is the fact that compels the consideration of a second class of forces, previously mentioned as the inertia forces.

First: What is inertia? I am going to define it by giving, in simple form, the fundamental law of motion. Here it is:

A body at rest will remain at rest forever unless acted on by some external force.

A body in motion in a straight line will remain in motion at the same rate, and forever, unless acted on by some external force.

It follows from these simple laws that it takes power to start a motionless body, and that it requires force to stop a moving body; and it is not a long or difficult step to the conclusion that: *if a body is started from a state of rest and given a certain velocity, it will take just as much power to bring the body to rest as it did to give it that velocity.* This statement, moreover, is not theory only, but practical truth, and the natural outcome of sound mechanical principles.

In view of this, what shall we say of the statement recently published in certain papers, that it takes much greater power to stop a moving train than to start one? And yet this is not an extraordinary case of a delusion arising from an imperfect recognition of fundamental principles.

In pursuing our investigation of the action of the inertia forces, we must remember that we are, at present, only studying them with relation to smooth running. The problem before us is to determine how, and to what extent, these forces act to mitigate the shocks which are, as we have seen, so disastrous. First, we must see how this force of inertia is distributed throughout the stroke. Evidently there are two things to be done: the piston, crosshead, etc., must be started from their position, and quickly set in rapid motion, and must afterwards be checked and finally brought to rest at the end of the stroke. A hasty glance would, perhaps, lead one to say that the force required to start the reciprocating parts would be the same at both ends of the stroke, and that at the middle of the piston stroke the parts would be in full motion, and hence there would be no inertia force at all. Unfortunately for steam engine builders and designers, this is not so. It is one of the unfortunate results of having to transform straight line motion into rotary motion, that it results in an irregular motion of the piston. We will now study this and see as to its nature and the amount of irregularity.

In Fig. 1 let the circle represent the path of the crank pin of a stationary engine. We will take $A\ C\ M$ as the line of engine centers, and suppose that the length of the connecting rod is three times the length of stroke, as is good practice. Then setting a pair of compasses to three times the diameter of the circle, and resting the point at A, we may mark an arc at A', which will represent the position of the center of the crosshead pin at the beginning of the forward stroke.* Keeping the same radius and setting the point at C, we may mark an arc at C', which gives the position of the crosshead pin center at the beginning of the backward stroke. Now divide this distance $C'\ B'$, and the point midway between them,

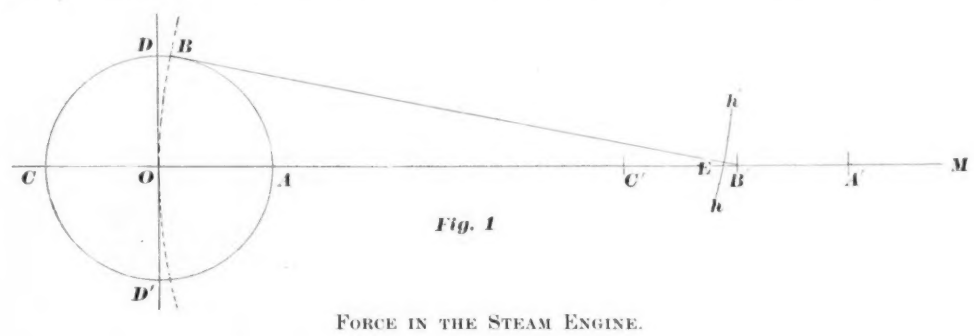


Fig. 1

FORCE IN THE STEAM ENGINE.

or B, will be the position of the crosshead pin at midstroke of the piston. But on setting the point of the compasses, with radius $A\ A'$, at B', and marking an arc $O\ B$, we see that it does not pass through D, but through a point B back of D, so that when the piston is at the middle of its stroke the crank pin is not at the middle of its stroke yet. Now, with well-balanced pulleys, such as all engines have now, the crank motion can be regarded as practically uniform. It follows, then, from the figure, that the piston makes half of the forward stroke while the crank pin makes less than half its motion for the stroke, and that the last half of the forward stroke is made while the crank makes more than half its movement. That is, the piston motion is faster at the back end, or head end of the stroke, than it is at the front or crank end. Considering the backward stroke in the same way, we shall find that the piston motion is slower at the crank end than at the head end. Accordingly, adding up, we see that that part of the piston motion which lies at the right of B' is made more rapidly than the half which lies to the left of B'. It will readily be seen that, knowing the length of stroke, length of connecting rod, and revolutions per minute of any engine, it is easy to determine, by means of a drawing made to scale, the average piston speed for both halves of a single stroke.

Let us illustrate by an example: Suppose an engine 18" x 38", making 100 revolutions per minute, length of connecting rod = 6 cranks. Referring to Fig. 1, make the circle $C\ A = 38''$ on some convenient scale—say $\frac{1}{8}'' = 1''$; then $C\ A = \frac{38}{8}$ inches. Draw the line of engine centers $C\ M$ and the perpendicular $D\ D'$. Then the points D and D' will be the crank-pin positions at the middle of its movement. Take now a radius, with the compasses, equal to three times the length of stroke = 6 times the length of crank, on the same scale as was adopted. Then resting the point at C, mark an arc C'; then resting the point at A, mark an arc A'. The points A and A' are the crosshead pin positions for the two ends of the stroke. Now rest the point at D and mark an arc $h\ h'$, crossing the line of centers at E. This point will be the point where the crosshead pin will be when the crank has completed half its throw. Now carefully measure the distance $A'\ E$, remembering that $\frac{1}{8}'' = 1''$ by our scale. Divide this distance $A'\ E$ by $\frac{38}{8}''$, or the whole stroke, and the resulting fraction will be that part of the piston stroke which is executed while the crank makes the first half of the forward stroke. For instance, suppose in the present case the distance $A'\ E$ was $\frac{9}{8}''$. Dividing $\frac{20}{8}$ by $\frac{38}{8}$, we get $\frac{10}{19}$. That is, while the crank makes

$$\frac{9.5}{19} = \frac{1}{2}$$

its stroke, the piston makes $\frac{10}{19}$ of its stroke. Or, expressing the same result in inches, we saw above that the distance $A'\ E$ was $\frac{20}{8}''$; this on our scale = 20" of the stroke.

It will be seen that this irregularity of the piston motion increases as the length of the connecting rod decreases, and decreases as the connecting rod increases in length, till finally, when the rod is infinitely long, it will disappear.

The practical effect of all this on the movement of the reciprocating parts is that they have to be started quicker at the back end than at the front end, and consequently the inertia force, or resistance to motion, is greater at the back end than at the front end. Again, on the back stroke the reciprocating parts are moving faster as they approach the back end, and consequently their inertia, or resistance to being stopped, will be greater at the back end than at the front. To sum up: Inertia is always greatest at the back end of the stroke.

* By forward stroke is meant the stroke during which the crosshead moves away from the cylinder.

The Practical Engineer (of London), in its issue of September 21, illustrates and describes a universal grinding machine, built by Smith & Coventry, Salford, which is stated to possess "several novel features that especially recommend it as a tool for an engineer's workshop." Since the cut and description of its functions show that the machine is almost an exact reproduction of the well-known Brown & Sharpe universal grinding machine, even to the details, the statement quoted above will scarcely be disputed in this country.

LETTERS FROM PRACTICAL MEN.

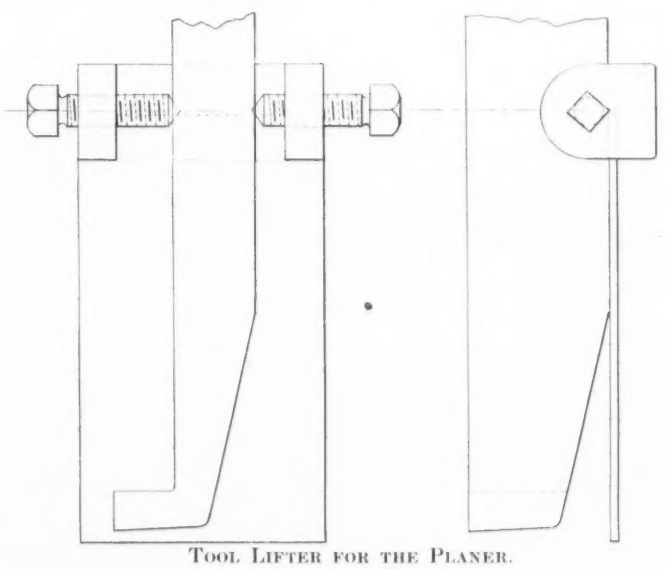
A Tool Lifter for the Planer.

Editor American Machinist:

I send you a sketch of a device for raising the tool on a planer, when cutting a T slot. I think it is a good deal better than fastening the clapper of the planer or the tool. It is simply a piece of flat iron, thick enough to allow a $\frac{5}{8}$ set screw to work in nicely. I will omit sizes, for of course it must be made to suit size of tools used and depth of slot cut. The lugs for the screws are bent at right angles, so it will go over the tool, and the set screws have their points sharpened so they will work in center punch marks on the tool. It is put on the back of the tool; then, when the tool goes through its cut, this device swings on its centers away from the tool, and slides over the top of the work; then at the end of the stroke it swings to its place against the tool again, and as the work comes back strikes against it and lifts the tool up, causing it to slide over. Most all machinists know what a trouble it is to hold the tool rigid in its place; then, if it happens to get loose, there is a wreck, and if that don't happen, the cutting edge of the tool gets dull very soon, on account of being pressed close to the work on the back stroke.

WORKMAN.

Johnston, Pa.



TOOL LIFTER FOR THE PLANER.

[We think no planer man will fail to see that here is a device worth far more than what little trouble and expense is involved in making it. Some planer hands always lift the tool by hand on the back stroke when doing such work, and we think that, where it is possible to do so, it is much better than to fasten the tool and let it drag through; but either way it is very liable to catch, and when it does the consequences are not usually very pleasant. Here is a device by the use of which all trouble of that kind can be avoided. By having room enough between the lugs, and making the set screws sufficiently long, it can be thrown over to one side or the other for right or left-hand tools. It is better for almost any tool not to let it rub over the work on the back stroke, especially when taking a finishing cut with a heavy tool; and devices have been applied to planers for automatically lifting the clapper at the beginning of the back stroke, in order to prevent the tool rubbing over the surface of the work. In having the engraving made we took the liberty of changing it slighily, so as to make it in the form shown instead of making it of one piece of sheet metal, bent into shape. In this form the piece tapped for the set screws may be of iron, bent into shape and finished, with a piece of sheet steel riveted to the inside of it, which gives the advantage of a light, thin piece at the back of the tool, with ample depth of hole for the set screws.]

Leveling Long Shafts—A Bad Engine Wreck—About Vacuum.

Editor American Machinist:

I have been very much interested of late in the long line of shafting question, hoping that some one would tell how it was leveled. Supposing the line shaft to be 2,640 feet long, leveled with a straight-edge and level, commencing in the center and working both ways upon targets 10 feet apart, the shaft would form an arc, the radius of which would be equal to its distance from the center of the earth, bringing the shaft in its center 2" above its chord, or in other words, bringing the center of the shaft 2" higher than the ends, while the level would show that the shaft was level.

I knew of a case where the head engineer of an electric light plant got dissatisfied and wanted more money; the company would not pay it, and he left; results, the wrecking of three engines, with an aggregate of 455 horse-power, and a loss of some thousands of dollars

within thirty days ; the prompt discharge of a new man, a whopping big bill for the electric light company. Four parties were benefited by it. The old hand got a better job, two engine companies got big jobs of repairs, and the company hired another man, paying him more than the old one had asked. So much for one change.

Mr. Booth's paper on the importance of vacuum is to the point. I once set up an 800 horse-power independent condenser. After I had it set up and piped, using about 100 feet of pipe varying from 10″ to 4″, I started it and got but 25″ of vacuum. This was not enough, so I sealed off the outlet and pumped water in through the injection pipe until I had 20 pounds' pressure, which I maintained while I went around with a piece of chalk and marked all the leaks ; these were, with one exception, where the irons were put in to support the core in the cast-iron fittings. I then removed the blank, heated up the pipes and started the condenser, maintaining 20″ of vacuum while I went around with a pot of asphalt varnish and sealed the leaks. The result was, I very easily got 27″, after that ; a gain of 2″ in about two hours.

I like Mr. Booth's suggestions of the barometer and table, and think I shall try it, as I am running a pair of 30″x72″ Corliss engines, running ¾ condensing, developing about 800 horse-power ; feed water 110°, vacuum 28+″. I would like to ask one question right here : If the barometer was placed in the room as suggested by Mr. Booth, will it not give the density of the atmosphere in the room, and not that out of doors, leading one to err in his calculations ? PACKING.

Human and Machine Anatomy.

Editor American Machinist :

Apropos to the blunder of a designer mentioned by Mr. T. P. Farmer, in your issue of October 20th, page 1, who built a machine which could not be conveniently handled on account of not being adapted to the anatomy of the operator, I will say that I never think of being without several human models in my drafting-room—made to the various scales pertaining to the drawings on which they are used. These are constructed of pasteboard, cut out with a profile representing a vertical "fore-and-aft" section of an average sized man. The different pieces of pasteboard are jointed together with an ordinary eyelet at the neck, shoulders, elbows, hips, knees, and sometimes middle of back. There are, of course, two arms and two legs. They need not be very accurate, and take but a few minutes to make. Such a model can be laid upon a drawing of the proper scale, and the relative positions ascertained of treadles, tables, hand-levers and various projecting points, thus avoiding interferences and adapting handles, treadles, knee-levers, etc., to the anatomy of the operator, whom the model vicariously represents for the time being. Models of horses and other animals used with machinery can obviously be made in the same way. Other sections than the one mentioned can, if desired, be shown. For instance, a man can be shown in back or front view when used upon similar views of machines to be operated. OBERLIN SMITH.

Bridgeton, N. J.

Air in Pipes.

Editor American Machinist :

Among the unexpected things that happen is the flow of water in pipes. A few years ago the writer witnessed the water turned into a newly laid pipe, eight inches internal diameter, and some three hundred feet long. This pipe had a downward inclination of possibly one foot in one hundred, and only one bend, and that on an angle of perhaps 15°. At the lower end of this pipe was one six-inch outlet, and one four-inch. The six-inch outlet was divided into two three-inch and five one-inch outlets, and these were all wide open. The head of water was some eight feet, and when water was turned on it seemed as though it would rush right through, but it did not. After waiting some time, I ventured to suggest that a gasket without a hole had been left in some flange joint, but the mechanic who did the job said that he knew the pipe was clear, and explained that it was "air-trapped," something that frequently happened, and that the air would hold it for some hours, but that it would be all right in the morning. This was about four o'clock in the afternoon, and the next morning the watchman reported that it came through with a rush at about ten o'clock in the evening.

Afterwards I saw another pipe put down, straight and level, but not so long, and when water was turned on, there was the same trouble. I have seen water turned on to street mains with but one 2½″ hydrant open, and the water went through all right, and these are the only two cases of the kind that have come under my observation where the air has bothered, except sometimes in the suction pipes of pumps. Here we often have trouble from air, probably from the same kind of air trap mentioned in the preceding instances.

Another place where air in pipes gives trouble is in syphons, and the air in this case collects at the highest point, and acts as a closed valve.

J. T. Trautwine mentions a case of this kind in his Pocket Book, with the method of trying to get rid of it with an air trap placed at the highest point, so arranged that, when the trap became filled with air, it could be shut off, and the air expelled by filling the trap with water, which in turn would prime the pipe and have a tendency to maintain a flow of water. The flow of water, however, would stop from an air collection in the pipe.

Some time since, in conversation on this subject, a gentleman told the writer of a similar incident mentioned by Mr. Trautwine ; it was his experience in carrying water to a dwelling-house. As there was an elevation, he carried it over by a syphon, and as he had been liberal in giving a pipe of large area up to the top of the elevation, he thought he would economize by finishing with a smaller pipe. The result was, that the flow of water was not of long duration. After becoming thoroughly satisfied that it was impossible to maintain the flow, before giving up entirely, he took out the small pipe, and in its place put in one larger even than the one leading to the elevation, and had the satisfaction of seeing the flow of water maintained fairly well.

By allowing a small opening at the lower end, so as to keep a small stream constantly running, is an improvement over shutting it off tight. W. E. CRANE.

Waterbury, Conn.

Cutting Cold Steel.

Editor American Machinist :

In answer to J. G., Westchester, N. Y., about cutting hot and cold steel, I would state my experience, which goes to prove that you must run the saw slowly for cold steel, and not at a high speed.

For hot steel the saws are usually about 3′ 6″ to 4′ 6″ diameter, and run at high speed (800 to 1,000 revolutions per minute). The teeth are simply punched out, and when worn, re-punched. For cold steel, both band and circular saws are used, and the speed is according to what is being cut, and varies from 100 to 300 feet per minute. These circular cold steel saws are now much used for cutting off the "head" of steel castings, and answer better and are quicker than the older method of cutting off in the lathe or slotting machine. ERNEST W. NAYLOR.

Literary Notes.

THE AMERICAN STEAM ENGINEER, THEORETICAL AND PRACTICAL : With examples of the latest and most approved American practice in the design and construction of Steam Engines and Boilers of every description. For the use of Engineers, Machinists, Boiler Makers and Students. By Emory Edwards, M. E. Illustrated by seventy-seven engravings. Philadelphia : Henry Carey Baird & Co., 810 Walnut street. Price, $2.50.

In this work the author treats the theory of the steam engine, combustion of fuel, forms and construction of boilers, boiler economy, economy in the use of steam, and kindred subjects connected with steam engineering. The different parts of the engine are treated of in detail, and the same is true of boilers ; valves and valve motions are discussed, one chapter being devoted to "How to set a slide valve." The United States regulations for steam boilers are given, and rules for finding the mean pressure of expanding steam, etc. Different forms of modern steam engines are considered. Considerable space is devoted to steam yachts and their machinery. In the appendix various subjects connected with engineering practice are considered.

The Elements of Electric Lighting, by Philip Atkinson, A. M., Ph. D. As stated in the preface, "the object of this volume is to meet the demand for a complete, comprehensive treatise, setting forth the various facts pertaining to electric lighting, in plain language, devoid of technicality and perplexing mathematical formulæ, from which business men, mechanics, and those who have the care and management of dynamos and lamps, as well as general readers, may gain a knowledge of the principles and construction of the apparatus by which this light is produced, and of the nature of that invisible, intangible agency which is its prime cause." It is a book which will be welcomed by those who for any reason wish to get a good and clear idea of the construction of electric lighting apparatus, and of the principles governing its construction and use, yet who have not the time or opportunity for deep mathematical or technical investigation of the subject. The first chapter is devoted to an explanation of the accepted theory in regard to the nature of electricity ; after which follow chapters on The principles of the dynamo ; Alternate current dynamos ; Direct current dynamos ; Electric terms and units ; Electric measurements ; The arc lamp ; The incandescent lamp ; The storage battery ; and Electric distribution. The publisher is D. Van Nostrand, New York.

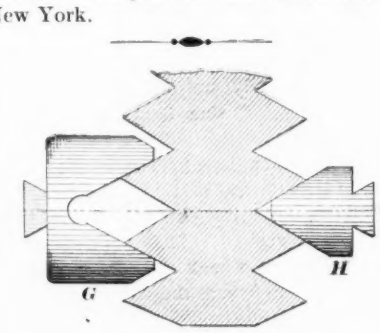


Fig. 10

Original Diameter of Taps and Bolts.

BY PEDRO.

In treating this subject in the AMERICAN MACHINIST of October 13, single-threaded screws only were considered. Multiple-threaded screws are never used for general purposes, and hence the subject is not worthy of much attention on this line. Since these screws are generally used only for special purposes, it makes little or no difference whether they are made to some standard size or not. If the nut is fitted to the screw, or *vice versa*, we have all that is required. There is only one case I can think of in which it seems desirable to keep a multiple-threaded screw to a standard size, and that is in case where such a screw is used on a machine which is manufactured in large quantities, on the interchangeable system. In that case—if it is not a square-threaded screw, which it is, in nine cases out of ten—there is a better method for measuring the diameter than that presented by Jarno in the AMERICAN MACHINIST of September 29, 1888.

In developing this subject it has been a special study of the writer to avoid, as far as possible, the use of loose pieces or accessories to the measuring instrument for adjusting it. There is nothing so convenient to keep in proper adjustment as the ordinary micrometer caliper, where the measuring points are simply brought in contact with each other when the scale reads zero. This principle has been retained in the screw micrometer illustrated in Fig. 5*, and need not be discarded in case of multiple-threaded screws. On all multiple-threaded screws having an odd number of thread spirals, a thread will always lie opposite a cut or space, as shown in Fig. 3, and can be measured with the screw micrometer shown in Fig. 5, as previously explained. When there is an even number of thread spirals, a thread, or a cut, will always be found on opposite sides of the screw, as illustrated in Fig. 10. In this case we simply replace the measuring point *G*, Fig. 5, by a wider one—one wide enough to reach over two threads, as shown at *G*, Fig. 10. This leaves the principle of adjusting the instrument the same as before—adjusted to read zero when the points *G* and *H* are in contact with each other. The reading of the instrument, in this case, will always be the exact diameter of a sharp "V"-threaded screw. To find the correct reading for a U. S. standard thread we must add one-quarter of the depth of a sharp "V"-thread to the diameter of the screw ; that is, the

Reading = Diam. of screw + .2165 × pitch.

The pitch in this case is the distance between two consecutive threads, and is obtained by dividing the lead of the screw by the number of thread spirals.

Example : What is the reading for a screw 1″ diameter, U. S. standard thread, double threaded with ½″ lead ?

Ans.—Pitch = ½″ ÷ 2 = ¼″ ; hence

Reading = 1″ + .2165 × ¼ = 1.054125.″

My attention having been called to some errors in the third column (reading of instrument for U. S. Standard thread), of Table III, under date of October 13, I will repeat the table here, giving the dimensions correctly to six places of decimals.

TABLE III.

Diam. of Screw.	Threads Per Inch.	*Reading of Instrument.*	
		U. S. Standard.	"V" Thread.
¼	20	.217525	.206700
5-16	18	.276417	.264389
⅜	16	.334406	.320875
7-16	14	.391107	.375643
½	13	.450088	.433385
9-16	12	.508375	.490333
⅝	11	.565955	.546273
¾	10	.685050	.663400
⅞	9	.802833	.778778
1	8	.918812	.891750
1⅛	7	1.032214	1.001286
1¼	7	1.157214	1.126286
1⅜	6	1.266750	1.230667
1½	6	1.391750	1.355667
1⅝	5½	1.506909	1.467544
1¾	5	1.620100	1.576800
1⅞	5	1.745100	1.701800
2	4½	1.856687	1.807556

The original table is correct to within less than one-half of one-thousandth of an inch, which is near enough for general practice, but the present table, it is hoped, will suit even the most fastidious.

The third column of the former table was not calculated from the formula (2), given October 13, but was obtained from a table of screw threads in "Nystrom's Pocket Book of Mechanics," page 363, 18th edition. One column of this table gives the diameter of the screw at the bottom of thread. Subtracting this from the diameter of the screw gives the double depth of the thread, one-half of which, subtracted from the diameter of the screw, gives the diameter, *d*, at the center of thread, or the reading of the instrument. The diameter at the bottom of thread being given in this table only to three places of decimals, the results obtained from it are, therefore, proportionately inaccurate.

The third column of Table I was obtained from the same source, and this table is, therefore, slightly inaccurate, but as the discrepancy is very small, and this table was used only to find the angle **T**, Table II, of the measuring points, or rather to indicate how it can be found in any case, the result is practically all right.

The present table was calculated from the formula.

In England a tire is made for the wheels of road vehicles, which, instead of being of uniform width, is made wider at intervals of a few inches, the object being to avoid the breakage of wheels and axles when coming against the side of street car rails.

The shoulders between the wide and narrow parts are sufficiently abrupt to make the wheel mount the rail as soon as one of the shoulders comes in contact with it, and the sliding and sidewise pulling, which is the cause of so many wreckages of carriages and wagons in cities, is avoided.

* For Figs. 1 to 9 see AMERICAN MACHINIST of Oct. 13, 1888.

Practical Details of Blacksmithing.

By B. F. SPALDING.

CULTIVATOR SHOVELS—GAUGING IRREGULAR SIZED PIECES—HEATING STEEL—DRAWING BEVELED EDGES—BENDING WITH "BULL-DOZER"—ADVANTAGE OF VARIABLE SPEEDS—BENDING AND STRAIGHTENING WITH DROP.

A small agricultural machine for shallow cultivation, intended to be drawn by one horse only, and termed a garden cultivator, is put upon the market by a number of different makers, at a very small profit, and great efforts have been made to produce it cheaply, in large numbers.

The pieces of steel for making the shovels for a lot of these came from the steel makers, of a shape similar to that shown in Fig. 1, except that the bevel was not made around the edges, and there were no holes in them. The first thing to do to them was to punch the square holes for the attachment bolts. As the plate was to be made into an oval, reversible shovel, it was desirable that the hole should be midway on a line passing from point to point. There would have been no difficulty in gauging this, if the pieces had come uniform in size and shape; but although there were 10,000 in a lot, they were cut at the mill with dies which left nothing to be desired in the way of variety, either in shape or size. They were cut out by a man with "a good eye." That was evident enough from their very general resemblance to each other; but when a number of them were laid together, and compared, they revealed the startling disclosure that this man's personal equation was subject to erratic and spasmodic aberrations, irregular in their effects, and unequal in their operations. This had caused variations of three-quarters of an inch in the length and breadth of the pieces he had cut, and made it impossible to punch them central, if they were gauged with fixed gauges from one end, and one side.

To overcome this difficulty, two springs of equal pliability were used, one at each end, the arrangement being essentially as shown in Fig. 2, where *A* represents an adjustable bar, bent up on the ends, to which are attached the gauge springs *B B*, which are movable for adjustment forward and back, and which hold between the V-shaped depressions at the ends, the points of the shovel *C*, which, after being punched, is pulled off from the punch by the "take-off" *D*, which is secured by the same strong bolt that holds the adjustable bar *A*.

The spring on the right-hand side is set with the top a little higher than the bottom of the "take-off," and that on the left is set with the top a quarter of an inch lower than the bottom of the take-off. The effect of this arrangement is that, as the piece lifts up, it rises over the spring at the left, while there is still tension from the right-hand spring against the punch, and therefore, when the punch is withdrawn clear from the hole, the spring releases itself by throwing the piece out of the way, leaving clear the space for the insertion of the next piece. It will be noticed that, as it is held and gauged by the points, the piece will always be struck by the punch in the same place, relative to them, and if it is set right, will make the hole midway on a line drawn from one to the other, notwithstanding there may be considerable variation in the sizes of the pieces.

After punching, the next thing to do to the shovels is to draw the bevel on them at the trip-hammer. As this bevel extends all the way around the blades to form the edges, it is necessary to heat them all over. In order to make good, cheap blades, the steel of which they are made should be high in temper in its natural condition, so that they may be hard enough for the purpose, without undergoing a separate operation of hardening; and to protect this highly carbonized material from the injurious effects of too high a temperature, it is necessary that care should be taken not to heat them any hotter than will just suffice to enable the operator to draw out a shovel at one heat. The hammer should be energetic enough to do this at a fair heat, for a second heating would be a waste of time, and detrimental to the quality of the steel.

All steel makers who have any pride in their reputation cry out loudly against the practice of taking "soaking heats." It is very bad practice to retain steel for any length of time even at a red heat, because while in this state its pores are open, and it will be very likely to get something or other into them which will not all go out when it cools, and they again become closed. This foreign matter must therefore be retained, locked up in the substance of the steel. Whatever this may be, it is very certain that the steel is of greater value without its presence. It is not thought that convincing proof has ever been given that anything more is needed in the elementary constitution of good steel than iron and carbon. Whatever is more than this, cometh of evil. Even the hydrogen which is shut up in the iron, which is obtained by electro-deposition, is deleterious. What then must the steel suffer, and what will it be good for, if it is kept at a red heat in an atmosphere of sulphuric and phosphoric fumes, intermingled with so much penetrating free oxygen, that scales form all over the steel, of sufficient thickness to cling together, and come off in a solid sheet? It is claimed that the presence of manganese, which it is

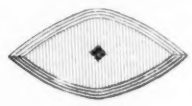


Fig. 1

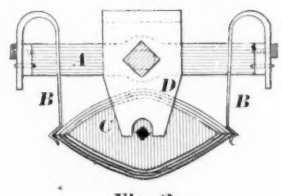


Fig. 2

Fig. 3

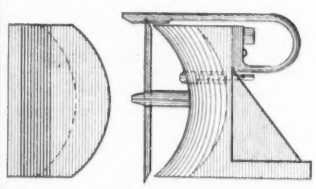
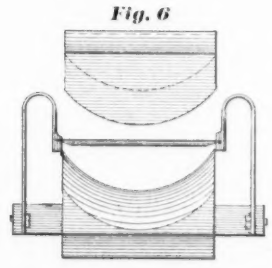


Fig. 4

Fig. 5

Fig. 6



now thought proper to introduce into the general run of steel, is a preventive against its shutting up oxygen, but that this active agent does penetrate to some extent is made manifest by the scale which is formed by its combination, and also by the fact that long exposure to a red heat makes the steel brittle. This is evidence that something has come between the particles of combined iron and carbon, which keeps them apart and militates against their firm cohesion.

The proper way to heat these shovels, therefore, is to always "keep the heat coming," as the blacksmiths say; that is, to have the work constantly getting hotter, and when the right heat is reached, take it out. To do this when three or four pieces are to be taken out per minute, requires that the fire shall be capacious enough to hold the number of pieces needed to be in heating, so that there may be no occasion to have a very fierce fire. If there are only four pieces in the fire, and there are to be four taken out every minute, the fire must be fierce enough to heat a piece in a minute, and to do this it will be so hot that the piece would be overheated if allowed to remain, subject to its action, for half a minute longer; while if there are twenty pieces in the fire, it need be only hot enough to heat a piece in five minutes, to yield four hot ones in a minute, and if, by accident, one of these is allowed to remain in a half of a minute longer than usual, it will still be within the limits to which it may be heated without suffering injury.

In fierce fires, the points and thin places of the objects submitted to their action receive accessions of heat faster than the conductivity of the metal is capable of conveying it to the thicker parts, and consequently these places are liable to become injured by overheating.

The rule for heating steel, which best fits economical as well as prudential considerations, is: heat as rapidly as is consistent with perfect safety. This sometimes requires very slow heating.

It has been intimated that the oxygen which, in the common air, is blown up into the melted mass in the Bessemer converter, does not all go through, is never thoroughly eliminated, but that some of it remains in the material, like the gas in aerated bread, which was at one time made by a somewhat similar patented process.

Whether any process which attempts to avoid producing this effect by introducing the purifying, refining, and consuming oxygen, by blowing it down into the molten metal, instead of up through it, will prove a "blooming" success, is a problem which is now being worked out at considerable expense, but, however it may be solved, the whole question recognizes the fact that there is danger to the good qualities of the steel, even in the admission into its substance of so pure, but active an element as oxygen.

When the shovel blade has arrived at the right heat, it is laid by the heater upon the anvil block, and the trip-hammer man, with a pair of tongs in each hand, seizes it and holds and works it around upon the flat lower die of the trip-hammer in such a manner that the beveled upper die, striking upon it, will give the proper slope to the edge all the way around it. The bevel is sometimes made with a drop, instead of with the trip-hammer, in which case the dies make the bevel all the way around at once, with a few blows, without having the position of the plate changed. To do this, however, it is of great advantage, if not absolutely necessary, to have the blades of uniform size before they are operated upon; as a small one, or one that was irregular in its form, would not receive the full impression of the dies, and would be imperfectly shaped.

In working the bevel under the trip-hammer, there is some trouble about getting the points evenly balanced, as the drawing of the bevel on one side first tends to throw the point to one side. This is not the case with the drop, and would not be under the trip-hammer, if space on the die could be afforded to receive a special impression, in which to form the point, with both sides beveled at one operation. Considerable practice, with the exercise of quick perception, enables the operator to produce a very fair looking job with trip-hammer dies, shaped in cross-section as shown in Fig. 3.

The next operation to advance the forging of the shovels is the bending. As they have considerable curvature in both directions, as shown in Fig. 5, it requires more power, to bend them with satisfactory rapidity, than can be exercised by the muscular force of one man. Either the horizontal bending machine or the drop will do the work to advantage. The dies for the horizontal machine, or "bulldozer," as it is called, are fastened to the bed plate and ram, so that they meet each other as shown in Fig. 4. The blade being heated to a uniform low heat, just red, is placed with the center hole on the guiding pin of the die, and the spring with an indented end bears upon the upper point of the piece, holding it in its proper central position, until the movable die comes up and forces it into shape, when, as it assumes the curved form in bending, it becomes shorter, and the spring no longer impinges upon it, so that, as the moving die recedes, the spring stud shown in the illustration presses the bent plate off from the face of the die, and it is then easily and quickly removed with the tongs, and another plate which the heater has meantime placed in a convenient position is then put on to be bent.

With the machine speeded at six, or even at nine strokes per minute, each stroke can be caught as long as the heater has one always in position. Allowing three minutes to a heat would require that the fire should contain 18 pieces to turn out 6 per minute, or 27 pieces to get out 9 in the same time. It is better to have the machine speeded to catch every stroke, than to have it speeded a little too high. For instance, if the operator can just catch the stroke at six per minute, and the machine is run at nine, the consequence is that he catches only every other stroke, which reduces the output to nine in two minutes, and thus the gain in speed is a loss in time. This is frequently the case in working a punch press, and has led some of the manufacturers of them to suggest to their customers the advantage to be derived from having their countershafting run at variable speeds by means of cone pulleys. Pressing down the lock treadle at each stroke makes more work for the operator, but enables the machine to have a quicker motion.

In bending the shovels under the drop, the treadle is operated at every stroke, and as the blow of the hammer responds almost instantly to the pressure, they are brought into shape very rapidly, and the excess of force above what is used up in the bending, is spent upon the material, giving it some additional stiffness, and in fact allowing the operation to be performed at less heat, for this hammering seems to give a "set" to the metal, that is not obtained by simple pressure.

But hammering will not take all the elasticity even out of iron, not to say steel. An experiment which proved this once, came under my observation. There were some pieces to straighten, which were $2\frac{1}{2} \times \frac{3}{4}$ and from 18″ to 30″ in length. A drop with a hammer weighing 1,000 pounds, which had a fall of eight feet, was bought and fitted up with straight dies 18″ long, for the purpose of knocking out the crooks, but it was found that the scheme was not practicable; for the pieces with only a slight deflection, say an eighth of an inch to the foot, would retain it, or the greater part of it, without improvement from any amount of cold hammering.

The dies used with the drop for bending the shovel plates were set as shown in Fig. 6.

The plates were laid with the points placed in the indentions in the ends of the guiding springs, where they were held until the upper die struck them, and when they were bent, and the hammer had gone up, they were left free and unconfined on the lower die, and were pushed off with the hot one in the tongs of the operator, before he laid it into its place between the springs. The die which was convex in its cross-section was used at the bottom, because of the greater facility with which it could be kept free from gathering scales, and because the ends formed handy rests to lay the shovels on, in putting them into place.

After they were bent, it was found to save labor and time in the polishing, to have the shovels tumbled in the rattler until the scale was removed, after which the bolt holes were countersunk, and they were ready to be affixed to the handles, on which they were subsequently ground by solid emery wheels and afterward brought to a finish on buff-wheels. With the application of a coat of paint on the backs, and a mixture for the prevention of rust on the faces, the process of manufacture was complete, and the shovels were ready for market.

The first inventor of the sewing machine turns out, it would appear, not to be Howe, after all, but a man named Thomas Saint, who took out his patent in 1760, sixty years before Howe produced his machine. A machine made according to Saint's specification is now being exhibited at the Exhibition of Sewing Machines and Domestic Appliances, at the Royal Agricultural Hall, Islington.—*Engineer and Iron Trades Advertiser.*

A correspondent of a Glasgow paper says that in the large towns in Japan there is much clamoring for water service according to modern ideas.

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Changing our Day of Issue.

Beginning with next issue, the publication day of the AMERICAN MACHINIST will be changed, so that the paper will thereafter be published from New York on Thursday of each week. Arrangements have been made to supply news trade purchasers and mail subscribers accordingly. This change is expected to secure a more uniform distribution as to time than heretofore.

Railroad Rules and Accidents.

Just at this time there seems to be an epidemic of fatal disasters by land and water; the latest, at this writing, being the frightfully fatal collision on the Lehigh Valley road, by which over sixty persons lost their lives.

There is no need to recount the horrible details; our readers are already familiar with them. The indications at this time are that the railroad company will make an effort to throw the blame onto the trainmen, on the ground that they failed to obey the rules of the road, and are therefore solely responsible for the accident.

But who is usually responsible for the failure of railroad men to obey the rules of the roads?

The public cannot enforce the rules of railroad companies; only the companies themselves can do that, and they should be held responsible for every failure to enforce them, resulting in death or injury to passengers.

Many of the rules of railroad companies are habitually disregarded by the employes, and the management of the roads know it. Moreover, it is well known and understood by railroad men, that, at certain times and under certain circumstances, strict observance of rules by trainmen would cause delay in getting over the road, which would not be tolerated by the management; and at such times and under such circumstances the mere fact that a train has been taken over the road on time is positive proof that some of the rules of the road have been broken by the men in charge of that train. Are they censured for disobeying rules? Hardly; but if they fail to get in on time then they are censured, and if they habitually fail to make time, other men are put in their places who will make it, and whether or not, in order to do so, they violate rules, will not be inquired into very closely until an accident occurs and some one must be found to bear the burden of the blame.

We do not know that such was the case in this instance, but we do know that it is a common thing for railroads to have rules for the government of employes, which are utterly inconsistent with their time-tables, and with what is at times, if not always, expected of the men in the way of getting freight and passengers over the road; and every one at all familiar with railroad matters, knows that the getting of trains over the road on time is the first prime requisite, to which everything else is subordinated. Rules may be disregarded habitually, and with the knowledge of the management, and no one is seriously censured because it is perfectly well known that such violations are at times absolutely necessary in order to prevent blockades; but when an accident occurs as the result of such violation of rules, then the fact of the violation is pointed out, and expected to constitute a valid defense for the company.

This is wrong and unjust. Railroad companies should not only be expected to have rules calculated to secure the safety of the public, but should also be expected to see to it that those rules *can be* and *are* habitually observed.

A Magazine Story.

There is in this country quite a large number of workingmen and members of workingmen's families, who read and appreciate the literary and artistic features of the monthly magazines, and there is no doubt that if all those who perform physical labor for a means of livelihood, and those who believe in the dignity and respectability of such labor, should cease to read them, there would be quite a noticeable falling off in their circulation. It is evident, though, that the editor of the *Century* is not aware of this fact, for if he were we think that selfish considerations, if nothing better, would prevent him from going out of his way quite so far and so often to insult and offend them.

The publication of the outrageously slanderous story, "The Bread Winners," the author of which has always been ashamed to reveal his identity, was a notably flagrant instance of this, partially atoned for, we feel bound to say, however, by the publication of Washington Gladden's excellent contributions on subjects connected with the labor question.

Recently there have been several indications that, in the opinion of the editor, no one was capable of appreciating, or was likely to read his magazine, except those far above the disgrace of manual labor.

Theodore Roosevelt furnished one of them when he declared the lawless and murderous cowboy to be far superior to the workingmen found in cities. The editor furnished another when he declared in substance that mechanics, simply by reason of their being mechanics, could not possibly be intelligent enough to teach in technical or trade schools. The latest example is a story called "A Strike," which, being absolutely without literary merit, and unaccompanied by any of the engravings, the presentation of which, we are forced to believe, is the only real object in the publication of many of the articles in this magazine, is, it would seem, published only because it is supposed that those who have sufficiently refined tastes to read such periodicals, are pleased by the reading of anything which seems to show working people in the light of naturally inferior beings, in whose appearance, dress, language and actions, no traces of intelligence, taste, or even honesty, are to be expected.

The modern magazine story writer, however insipid and flat his productions may be, prides himself especially in depicting his characters with absolute fidelity to life, and the publication of a story by the *Century* is of course proof that its editor considers its characters correctly drawn.

Every one will recognize in this story a very accurate description of American workingmen and women. Not one of them can speak English with any approach to correct form, while the language of the superintendent of the mill, who is also frequently referred to as the "master," is the pink of perfection. "The master" is also a very beautiful man, and "made a fine picture, with a broad, tall figure, an honest, serious face, with bright blue eyes, and a wide white forehead," and possessed "the rare combination of great sweetness and great strength," and so on *ad nauseam*. We are not enlightened as to the personal appearance of the men who worked in the mill, but from the fact that the wife of one of them (the only one whose personal appearance is described), is depicted as having a "brown, wrinkled face, devoid of teeth, and ornamented with a huge pair of shaggy gray eyebrows," and is made to appear at midnight before the window of the room in which the beautiful wife, and still more beautiful sister-in-law of the sweet master were sitting, and nearly frightened them out of their senses by the sheer ugliness of her face, it is to be inferred that the men were, to say the least, not Adonic. Further along we have a description of a young man whose beauty is almost equal to that of "the master's," though of a different type, but that is accounted for by the fact that he had been born in a house owned by "the master." All the books he had ever read were furnished by him; he had been to church all his life in a chapel built by "the master," and finally had been away four years getting an education, the means for which were furnished by "the master." Then, too, he had been selected as the superintendent's assistant; but we are left in doubt as to whether his beauty was the result of his selection for that exalted position, or whether the selection was the result of his beauty.

While the mill was shut down (due solely to the folly of the employes, of whom "the master" said, "They are fools, that is all"), over-dressed girls were to be seen in the streets, which later "seemed to grow fuller of idle rowdies and over-dressed girls," while "the rival liquor saloons were doing a brisk business." A committee was appointed by the employes to confer with "the master," but not one member of it was respectable, and the only one who possessed sufficient intelligence to do any conferring was an apothecary's clerk, who could not speak decent English, and who finally stole his employer's store and business, all because he allowed himself to become temporarily associated with workingmen. The other two members of the committee made lots of money in some occult way not specified, but one of them drank it up, and the other bought his wife a "sealskin dolman," handsomer than that of the wife of the master, who observed to her, in speaking of the wicked and ugly work people, "*whether they work or not, the capitalists have got to support them, directly or indirectly*," from which we should infer that the master's knowledge of political economy was hardly equal to his beauty and sweetness.

The story is full of such brilliant points we only wish we had space and time to allude to all of them, but it finally concludes, as most of the *Century* stories do, with an utterly irrelevant and idiotic declaration to the effect that "quiet reigned in the sick-room," and we are left in doubt as to whether or not the master recovered the use of his arm, which had been entirely blown away by one of the wicked and ugly workmen, and also as to several other things about which the writer might have informed us, if the ethics of *Century* story writing allowed it. We think no one who reads the story will fail to be impressed with its fidelity to nature, because nearly every one has had sufficient experience with American workingmen and their families to know that none of them can by any possibility be handsome, or sensible, or honest, or, in fact, possess any of the noble attributes which naturally belong exclusively to masters and superintendents and their families. Seriously, the story is a gross and outrageous insult to American workingmen and women, and it is a shame that any American magazine could be found willing to publish it. The worst of it is that thousands of *Century* readers will believe it to be a true representation of the people whom it pretends to represent.

Notwithstanding the fact that we publish every week, at the head of our Questions and Answers column, the statement that "Every question, to insure any attention, must invariably be accompanied by the writer's name and address," we are constantly receiving questions that give neither. If those who ask questions that are not answered will read the heading of this department, they may find the reason. Just at this time we are especially blessed with questions to which no name is appended. When a question is repeated it should be repeated in full. Unsigned communications go into the waste basket at once, and we have no further knowledge of them.

In the discussion of lightning conductors, by the British Association for the Advancement of Science, eminent electricians contended that no properly constructed rod had ever failed. M. de Fonville claimed that a large number of lightning-rods in a large city would protect the city generally from the effects of lightning. The rod must be insulated from the building, and should have several branching points from its upper end. A large sheet of zinc should be buried deep in permanently damp soil for the lower end of the rod. All metal work, such as vanes, finals, etc., should have sound metallic connection with the rod.

In England, the Board of Trade has ordered the principal railroads to furnish statements regarding the service of employes for more than twelve hours continuously, and it is thought that the Government is going to deal with the matter. We wish we could say that there was a probability that our Government would deal with the same question here. It is a question which sadly needs

dealing with, and the public must learn, and in fact, should have learned before this, that their only protection lies in legislation.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(475) Apprentice, Philadelphia, asks: Will you give directions for putting names on steel tools? I have noticed a man doing it with acid in the shop where I work, but he will not let me see him when he puts this acid on, I wish to know what kind of acid to use. *A.*—Use pyroligneous acid, 4 parts, alcohol 1 part by measure. Mix and add 1 part double aquafortis.

(476) J. J. K., Lancaster, Pa., writes: Our engine makes 107 revolutions per minute, and our pulley on the main shaft is 4 feet diameter. The 107 revolutions of the engine give us the required speed. Can we use a 3-feet pulley on our shaft, thereby decreasing the revolutions of our engine, and save steam? *A.*—If your engine is correctly designed for the work it has to do, you will increase the fuel expenses by decreasing the speed of the engine.

(477) W. N., ———, asks: 1. Can you tell me how they cut the thread on mop handles and sweeper brush handles? There is a thread of about ¼ inch pitch tapering. Is it done by a solid die or in the lathe? *A.*—We do not know how it *is* done, but if we had such work to do, we should try it by devising an attachment to the lathe to work similarly to the chasing bar on Fox lathes. You might ascertain how it is done by correspondence with manufacturers of wood-working machinery. 2. Can you tell me the name of a text-book for silver platers' use? *A.*—We do not know of a book devoted to the subject, but by procuring catalogues of the publishers of scientific and technical books, you may find what you desire.

(478) T. P., Jersey City, asks: How is it that water on wrought-iron preserves the tool, and with a finishing tool puts a beautiful surface and polish on the work, while the use of water, or, as far as I know, any other lubricant on machine steel (a very similar material), spoils both the tool and the work? *A.*—Perhaps some of our readers can give an explanation for what difference there is between the two metals in this respect. But the fact is that machine steel is worked with soda water, by various tools used in the drill-press, with as good results in this respect as are obtained with wrought-iron. And it is also worked in screw machines with oil as a lubricant, and just as fine surfaces secured as can be secured on wrought-iron by using water.

(479) H. B., writes: I had a belt 5 inches wide, 48 feet long, which was running on 16-inch pulleys, turning 198 revolutions per minute. It did not transmit the power required and consequently I replaced it by a 6-inch belt, which, running at the same speed, gives the power required. Now, what diameter of pulley would have been needed to replace the 16-inch ones in order to get a corresponding increase of power with the 5-inch belt? *A.*—By increasing the width of belt 1 inch, you increased its capacity 20 per cent. To give it the same increased capacity by increasing its speed, you would need pulleys 20 per cent. or 1-5 larger, which would be 19.2 inches. Consequently 20-inch pulleys would have given you the required increase, with something to spare.

(480) S. H., ———, Miss., asks: Please let me know how pattern makers mix up plaster of Paris to make moulds for casting lead letters. *A.*—Plaster of Paris is made by boiling or burning gypsum, a mineral consisting essentially of sulphate of lime and water. Gypsum deprived of its water by burning leaves a powder that, when mixed with its own bulk of water, forms a creamy paste which almost immediately becomes solid. In using plaster of Paris, the liquidity of the mixture should be regulated by the thickness of the body required. For thin bodies, two parts of water to one of plaster may be satisfactory; but for general work one of plaster to one of water will be nearly right. It seems to us that it will be cheaper for you to buy the letters in place of casting them yourself.

(481) Inquirer, N. Y., writes: I want to furnish steam to heat adjoining buildings, and would like to know what it will cost per square foot, and how to get at it. Say it will take 1,200 square feet of pipe to heat it at a temperature of 70 degrees. How can I find what each square foot will cost? *A.*—In the first place determine how many feet of pipe will be required, thus: Suppose 1-inch steam pipe is to be used for the purpose of heating the rooms. The outside diameter of 1-inch steam pipe is 1.26 inch, and its outer circumference is equal to $1.26 \times 3.1416 = 3.95+$ inches; consequently, the amount of heating surface in each foot of pipe will be equal to $3.95 \times 12 = 47.4$ square inches. Reducing this heating surface to square feet we have

$$\frac{47.4}{144} = 0.329$$

square foot in each foot of length of pipe. According to your example, 1,200 square feet of heating surface is required; hence

$$\frac{1,200}{0.329} = 3,647.41$$

feet of pipe will be needed for the 1,200 square feet of heating surface. Multiplying 3,647.41 feet by the price per foot, and adding your own cost of labor and other expenses for putting up the heater, you obtain the total cost of heater. Dividing this total by 1,200 you obtain the cost per square foot.

(482) G. S., Boston, Mass., writes: Please give me a rule for finding the number of holes in index circle of dividing head on milling machine, for cutting any given number. Worm wheel has 40 teeth. *A.*—The most convenient rule known to the writer is to place the number of teeth in the worm as the numerator of a fraction, and the number of teeth to be cut as the denominator. This fraction will then be the fraction of a turn required by the index pin, and the number of holes may then be easily found. For instance, suppose that 60 teeth are to be cut, then the fraction would be 40-60, which equals 4-6 or 2-3 of a turn; now any circle having such a number of holes as will divide by 3 will answer, and taking 2-3 of them, you will cut 60 teeth; if the circle has 12 holes, take 8 of them; if it have 15, take 10; if it have 18, take 12, and so on. Suppose 44 teeth are to be cut; the fraction will be 40-44 = 10-11, and you must find a circle having a number of holes divisible by 11. If the circle chosen have 11 holes, take 10 of them; if it have 22 holes, take 20; if it have 33 holes, take 30. Suppose 14 teeth are to be cut; then the fraction will be 40-14 = 20-7. Take a circle having a number of holes divisible by 7. If the circle chosen be 14, take 40 holes, which are 20-7 of 14, and will of course be 2 turns and 12 holes. If 21 is chosen, take 60 holes, or 2 turns and 18 holes. With a little practice you will easily make these computations mentally, and it is much better in every way to do so than to go by the tables furnished.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p 16.

Link-Belting.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Machinery Co., Chicago and N. Y.

See our new designed engine lathes in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed drill presses in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed shapers in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See our new designed brass working tools in Cincinnati Centennial Exposition, Lodge, Davis & Co.

2,000 feet of space in Cincinnati Centennial Exposition, Lodge, Davis & Co.

See special adv't, page 16, Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb-Knitting Machine Co., Chicopee Falls, Mass.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Drop presses, punches and shears. Williams, White & Co., Moline, Ill., manufacturers.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

"Swift" Sight Feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Selden Packing, for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Brown & Sharpe Mfg. Co. have a line of machinery with S. A. Smith, 23 S. Canal st., Chicago, Ill.

Patents—Whittlesey & Wright, 705 8th st., N. W. Washington, D. C. Send for pamphlet and references

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Upright drills, improved, sizes 21", 23", 25", 28", 32", 36" swing; finely made and great capacity. Currier & Snyder, Worcester, Mass.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

If you visit the Ohio Centennial at Cincinnati, see the Waterhouse Arc Light Plant. W. N. Gray, agent, 56 Longworth st., Cincinnati, Ohio.

J. W. Strange, Bangor, Me.—Dear Sir: We prefer your steel stamps to those of any other make. Darling, Brown & Sharpe, Providence, R. I.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N. Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N. Y. Send for des'n.

Fine tools and supplies for machinists and other metalworkers. Get our prices before purchasing elsewhere. Montgomery & Co., 105 Fulton st., N. Y. City.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See Oct. 6, p 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Contract work of all kinds executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with Rawson Mfg. Co., Hornellsville, N. Y.

A system of easy lettering by J. H. Cromwell, giving 26 forms of alphabets. The space to be lettered being divided into squares; simple and effective. Price 50 cents. Catalogue of books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st, New York.

"Practical Drawing," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including Nov. 3, 1888 issue, 62 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 76 articles have thus far appeared up to and including the Oct. 27, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES.

R. Lucas has started a machine shop at Athens, Ga.

There is strong agitation for water-works at Marietta, Ga.

M. S. Ketchum is building a planing mill at Corinth, Miss.

The Milton Knitting Company has been chartered at Milton, Pa.

Miller, Metcalfe & Parkin, Pittsburgh, Pa., will enlarge their works.

Marietta, Ga., is interested in establishing an electric light plant.

Eley & Sons, Hickory Creek, Ark., will rebuild their cotton gin at once.

The Adams Cotton Mills, at Montgomery, Ala., will add more machinery.

E. W. Barnes is building a machine shop, foundry and boiler shop at Monett, Mo.

W. S. Cox, La Grange, Ga., is putting up an addition to his plow works 75 x 100 feet.

D. F. Torbett is interested in establishing an electric light plant at Mobile, Ala.

The Troy (Ala.) Fertilizer Company will rebuild their works, recently destroyed by fire.

The Liddel Company, Charlotte, N. C., will build an addition to their machine shop 30x150 feet.

W. H. Beggs & Bros. contemplate enlarging their machine shop and foundry at Birmingham, Ala.

The Springfield (Ill.) Iron Company have opened an office at 164 La Ciede Building, St. Louis, Mo.

Baxter D. Whitney, Winchendon, Mass., will build an addition to his machine shop, 50 x 100 feet.

The San Antonio (Tex.) Electric Light Company has increased its capital stock from $50,000 to $100,000.

The Fiberite Manufacturing Company, Skowhegan, Maine, have begun work on a new mill in place of the one recently burned.

The Cleveland Chair Factory, at Cleveland, Tenn. recently burned, will be rebuilt at once, it is said. The works employed 200 men.

McIntosh, Seymour & Co., Auburn, N. Y., are erecting an addition to their shops 40 x 80 feet. They build compound engines for electric lighting.

The plant of the Minnesota Car Company, Duluth, Minn., will consist of a rolling mill, machine shops, foundry and car shops, having a capacity of thirty cars per day. Work will be begun at once.

There is water-works agitation at Bristol, Tenn. Tekamah, Neb.; Canton, Ohio; Louisville, Ohio; Delaware, Ohio; Morrilton, Ark.; Marietta, Fla.; Cleveland, Ohio; Columbus, Neb.; Denver, Col.

The Taylor M'f'g Co., of Reynolds, Ga., with a capital of $35,000, will be organized, to operate the Elmira Cotton Mills. Additional machinery will be added and improvements made at a cost of $20,000 to $25,000.

George W. Ditridge, James A. Dickey, W. W. Austell, M. M. Bartholomew and others have chartered the Southern Iron Car Line, capital stock $50,000, to manufacture all kinds of freight cars, etc., at Atlanta, Ga.

Cooke & Co., 22 Cortland street, New York, have taken the agency for the Niagara Steam Pump, and will hereafter supply users with all sizes. These pumps are made for a variety of purposes, as will be seen from the catalogue issued by Cooke & Co.

The *Kennebec* (Me.) *Reporter*, in concluding a review of the manufactories of Gardiner, Me., says: "Gardiner has every reason to feel that the coming winter will be a good one from a business point of view." The season's business has been a large one, and improvements and enlargements have been the general order of things.

Pedrick & Ayer, Philadelphia, Pa., have issued a small circular descriptive of the Universal Milling Machine built by them. The circular contains a copy of the report on this machine made by the Committee on Science and Arts of the Franklin Institute. The report commends the machine both for special work and for general use.

At a special meeting of the stockholders of the Fall River Iron Works Company, it was voted to increase the number of shares from 960 to 4,000, and its capital stock from $96,000 to $1,400,000. This is believed to be preparatory to the erection of a large mill upon the old iron works property, which is now owned by the American Printing Company.

The Barr Pumping Engine Company, Philadelphia, Pa., a new comer in the field, tested its first pump in May last, but finds itself already crowded with work, having recently taken orders for over fifty pumps. We note a fine pressure pump for Jones & Laughlins, Pittsburgh, now in the sand. It will furnish the hydraulic power for their Bessemer plant.

The Johnstown Steel Street Rail Company, of Johnstown, Pa., are having some specially heavy rail straighteners with engines attached, built for their new mill by William Tod & Co., of Youngstown, O. The same builders have under way Porter-Hamilton engines of 1000 horse-power for The Latrobe Steel Works; 300 horse-power for The Lake Erie Iron Co., and 300 horse-power for The Harvey Steel Co.

The Swindell Construction Company, of Pittsburgh, is now engaged in remodeling the tube department of the Riverside Mill at Wheeling for the use of manufactured gas. The other departments of the mill were originally constructed for the use of manufactured gas, the appliances for which will answer equally well for natural gas, while those of the tube department were made exclusively for natural gas, which necessitates a thorough overhauling and change in the furnaces before manufactured gas can be used.—*American Manufacturer.*

The Steelton *Reporter* of recent date says of the Pennsylvania Steel Works: This has been another busy week. No. 2 blooming mill, which has not been in operation for two months, was started up on one turn on Monday. No. 2 Bessemer has made a large production, averaging 950 tons each day this week. No. 1 open hearth has both furnaces in operation on special steels, and shows an average production. No. 2 open hearth is running very satisfactorily and made a number of steel castings. No. 1 blooming mill made an extraordinary output this week. No. 2 blooming mill is again in operation, after a shut-down of two months. But one turn is at work at present, and are rolling nail plate. The hammers had one turn on forgings for shipment all week, and the second turn on billets and slabs. The rail mill made an average production, and everything is shipped as fast as completed. The foundry completed several heavy pipe castings this week for the works at Sparrow's point, in addition to the usual quota for home use. The merchant mill made a fair output. The boiler shop is pressed with work for Sparrow's point, and the shipments are heavy. The machine shop has a large force of workmen on new work, and is pressed with orders. The frog, switch, and signal department is kept busy, with night and day turns, and has a steady flow of orders.

C. L. Redfield, 99 Stillman Block, Minneapolis, Minn., writes us: "There is an active movement on foot in this city to encourage manufacturing enterprises to come here. I will answer inquiries and give statistics to those who are looking for opportunities. For the sake of giving you an opportunity to lay some of these before your readers, I give you a few. There are sold in the territory immediately tributary to this city between 300 and 400 engines annually, yet not an engine is made here. Every engine sold here means boilers, pump, heaters, steam supplies and machinery, all of which can be made here to advantage. There is also an exceptional field for machine tools and wood-working machinery, neither of which are now made here to any extent. The number of engines sold annually indicates, to a certain extent, the very large demand for manufactured articles over and above what we make. As compared with New England, our advantages are great for manufacturing certain lines of things. Soft coal costs us $3.00 a ton, as against $5.00 in Massachusetts. We are 200 miles nearer immense iron deposits than Massachusetts is. With the exception of New York and Chicago, Minneapolis is the largest railroad center in America, hence the shipping facilities are the best to be had. New England has to find part of her market at long distances; we have a present and growing market, greater than it is possible to supply for several years. The nearest competing point of importance that Minneapolis has is 400 miles away, which cannot be said of any other city in America except San Francisco. The territory tributary to Minneapolis, and not nearer to some important point, is larger, has more population and more wealth than any city in America. These facts make this center exceptionally favorable for manufacturers who will locate here and take advantage of the situation. I have had talks with several prominent citizens, and they are thoroughly convinced that these statements mean a good deal for the city. I expect that many of them will take action and financial interest in new manufactures."

Machinists' Supplies and Iron.

NEW YORK, Oct. 18, 1888.

Iron—American Pig—There are no new features of interest in the general condition of trade, and prices are steadily maintained. We quote Standard Lehigh and North River brands $18.50 to $19 for No. 1 X Foundry; $17 to $17.50 for No. 2, and $15.50 to $16.25 for Grey Forge.

Scotch Pig—The market has ruled quiet and steady, with moderate sales. We quote Coltness, $21.75 to $22; Gartsherrie, $21; Summerlee, $21.75 to $22; Eglinton, $19.25 to $19.50; Dalmellington, $20.25 to $20.50; Clyde, $20.50, and Langloan, $20.50.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to examine S. S. planes; see p. 11.

Wanted—Travelers for New England and Middle States, to handle mechanical goods; liberal commission. Box 17, AMERICAN MACHINIST.

A superintendent soon at liberty desires to re-engage; locomotive and heavy machine work, foundry work, heating furnaces and forgings; boilers and steam work. C. M., care AM. MACHINIST.

Wanted—Position as supt. or general foreman of large machine shop, by a man 40 years old; has had charge 15 years, marine, stationary engines, all kinds of jobbing, etc. G. M., AM. MACHINIST.

Wanted—Moulder, young man preferred, with $3,000 to $5,000 capital, to take interest in foundry and machine shop located in thriving town in Northern New York, running on special line of work and doing good business. BOX 32, AMERICAN MACHINIST.

Wanted—A foundry foreman, one who is skillful, energetic and ambitious, who understands both locomotive and lighter work, and who would be willing under favorable conditions to get out the work at a price per pound. Address, with full record of experience, Box 522, Taunton, Mass.

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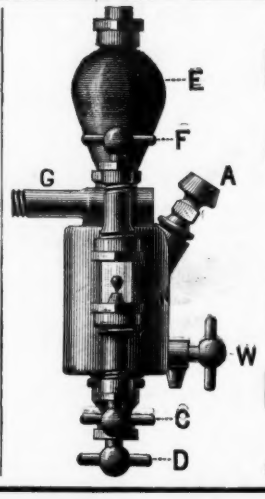

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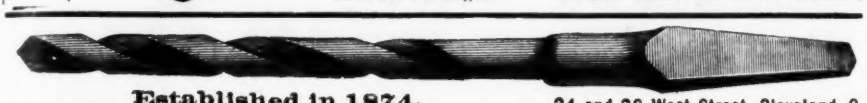

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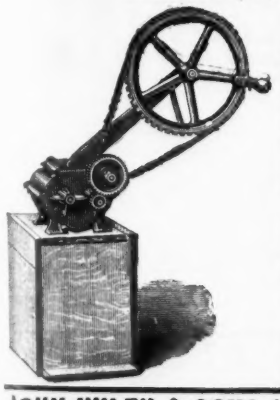

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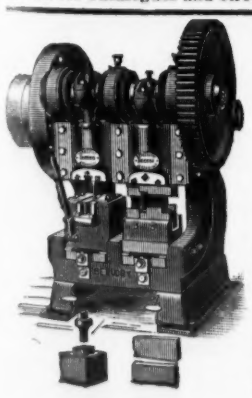

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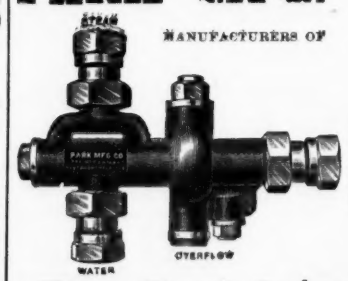

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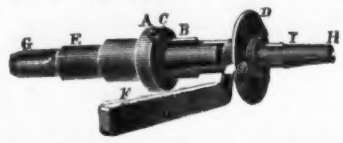

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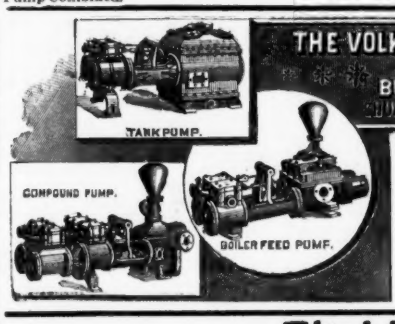

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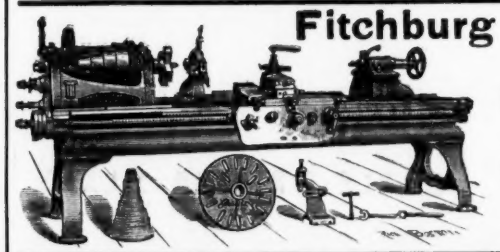

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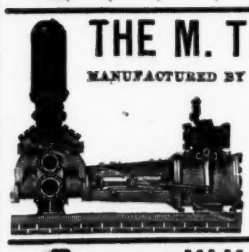

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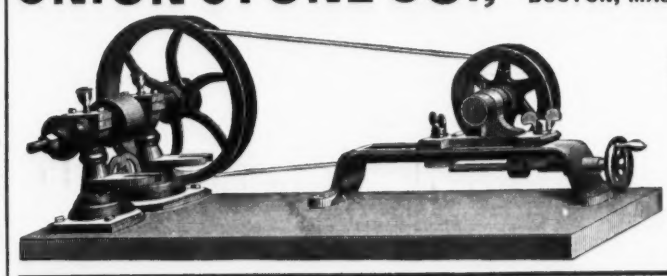

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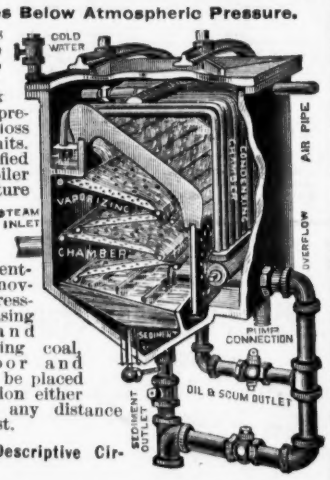

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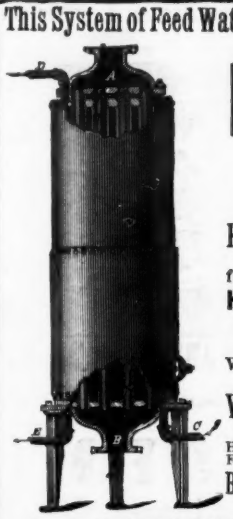

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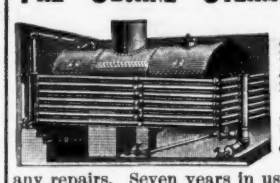

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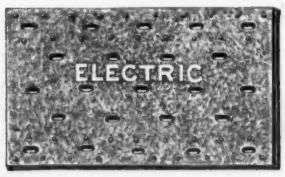

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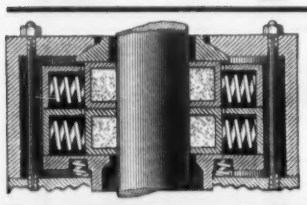

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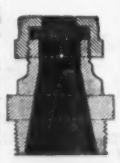

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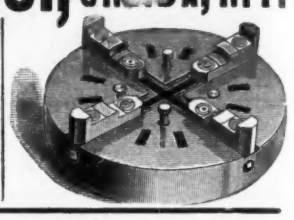

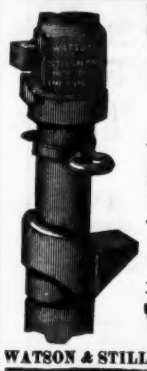

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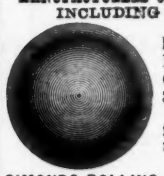

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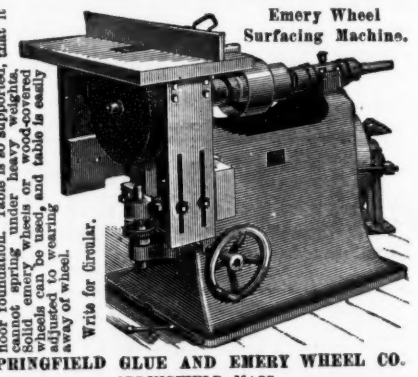

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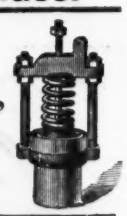

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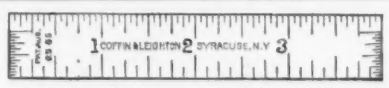

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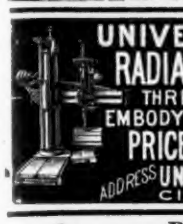

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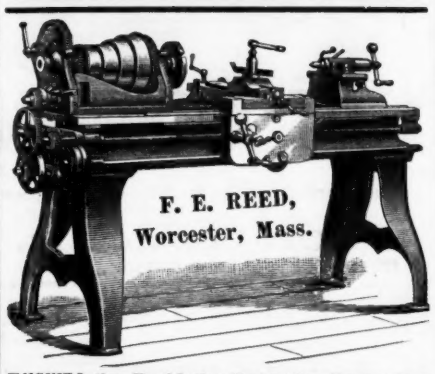

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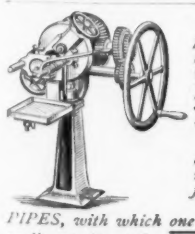

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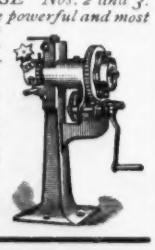

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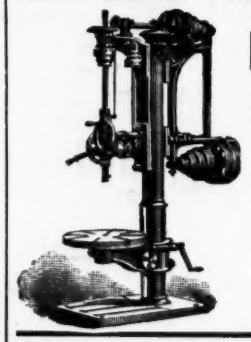

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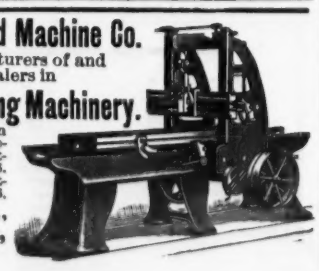

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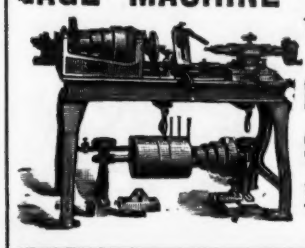

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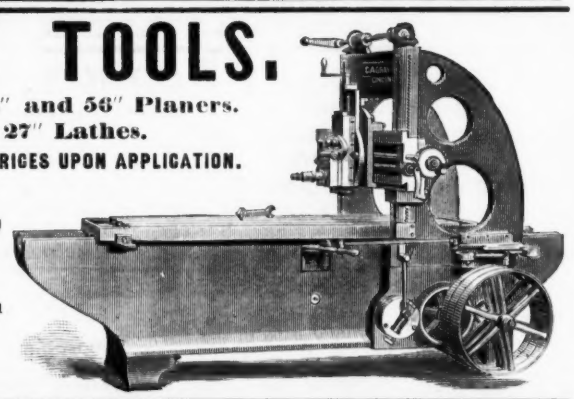

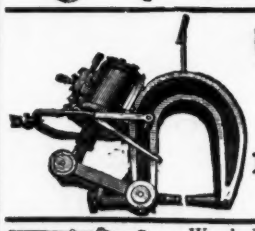

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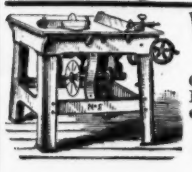

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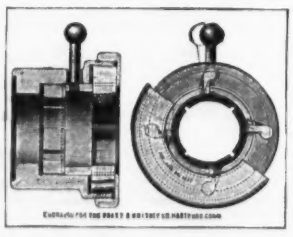

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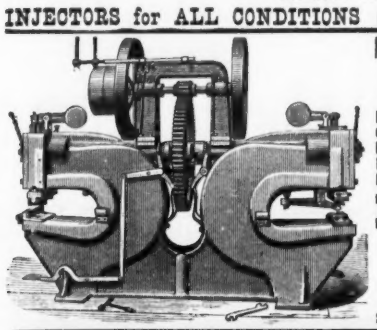

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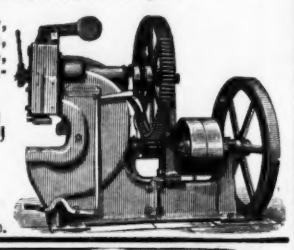

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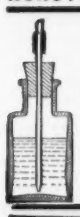

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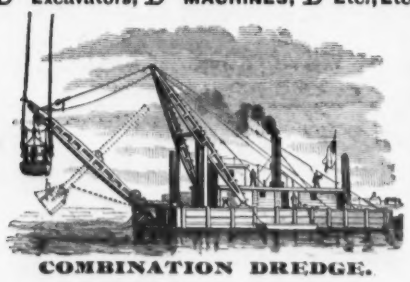

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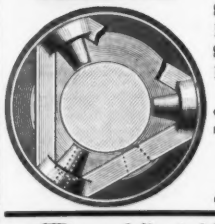

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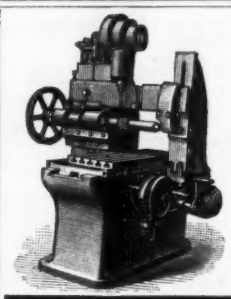

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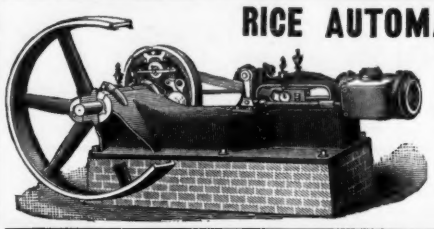

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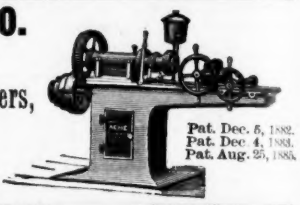

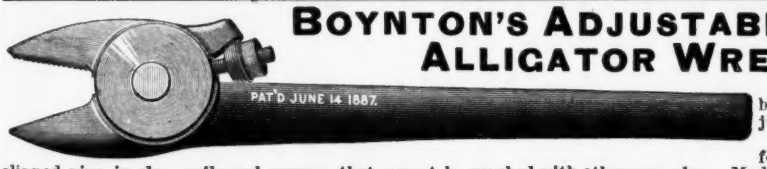

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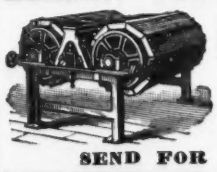

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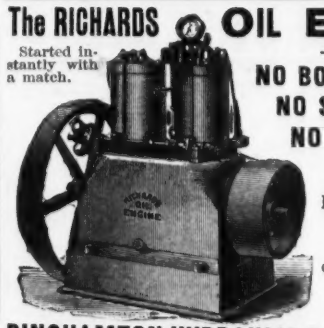

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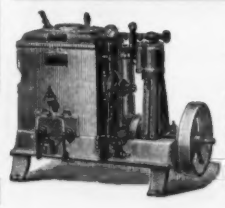

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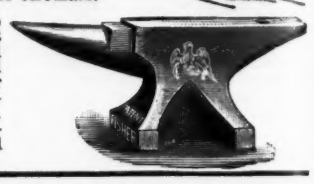

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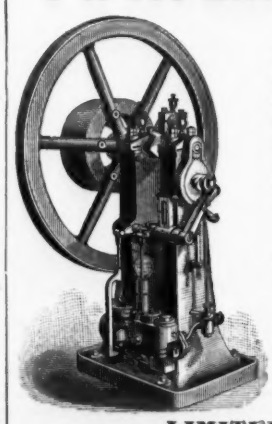

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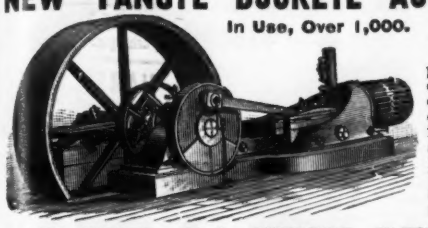

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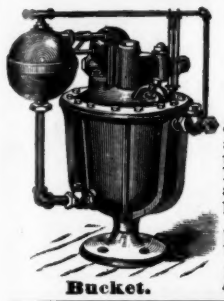

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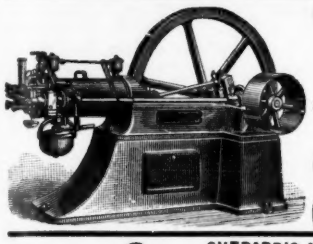

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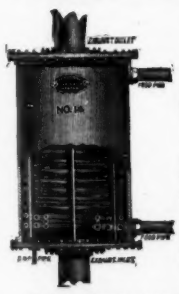

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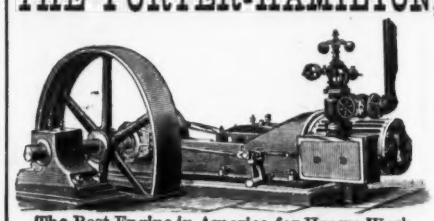

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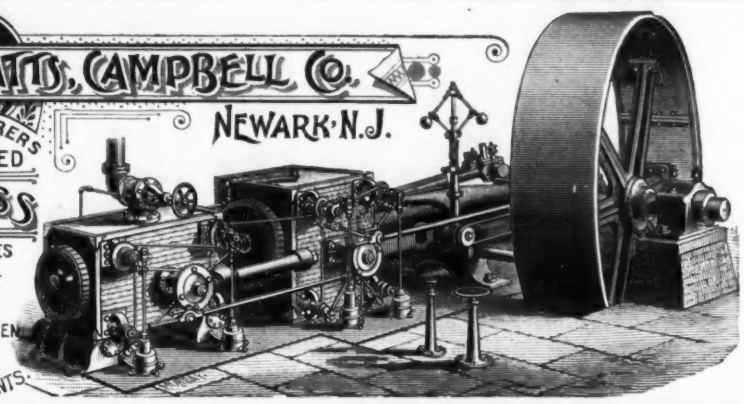

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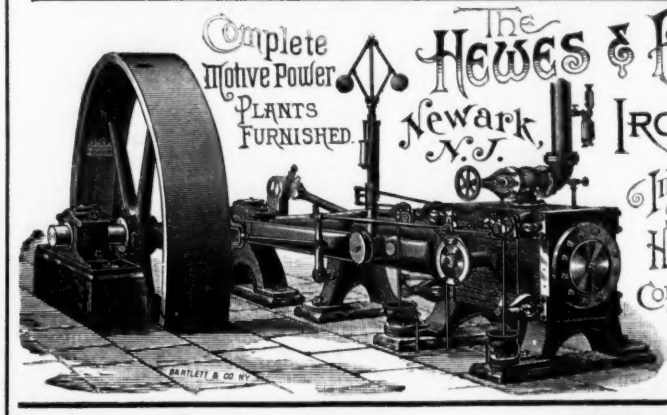

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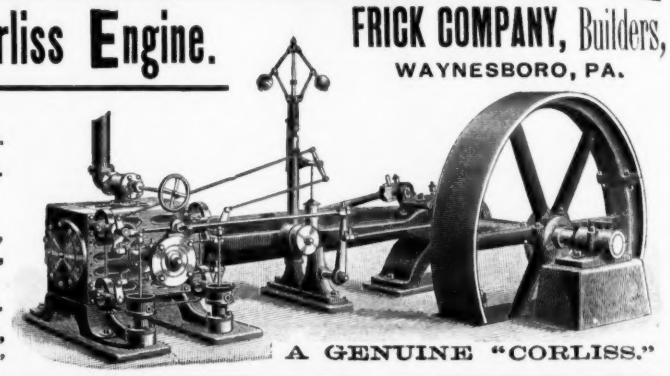

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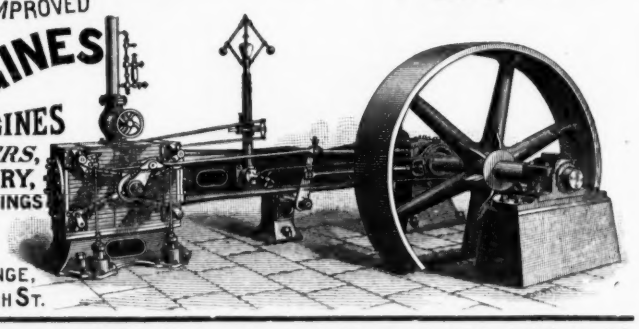

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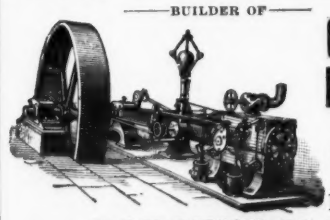

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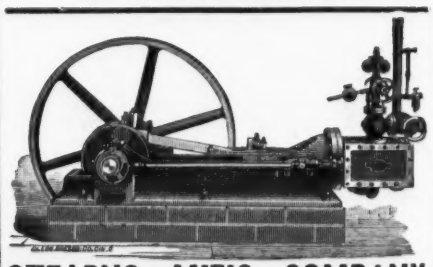

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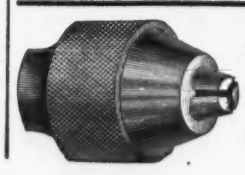

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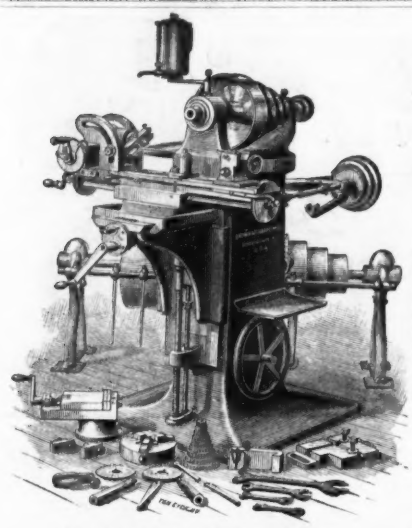

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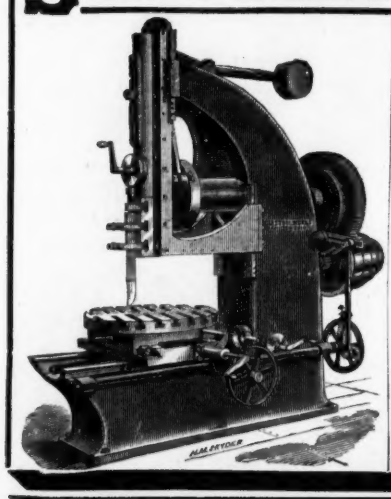

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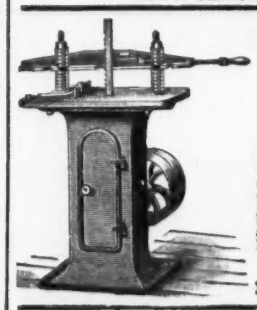

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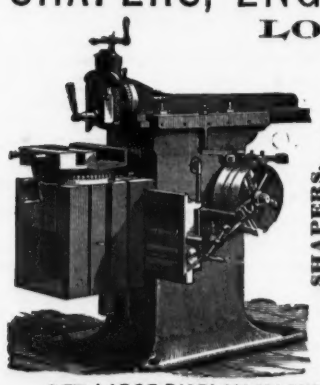

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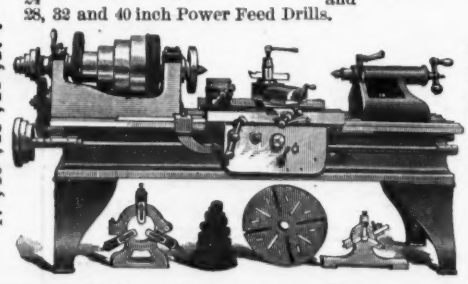

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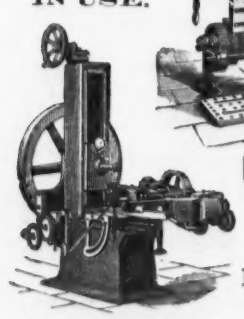

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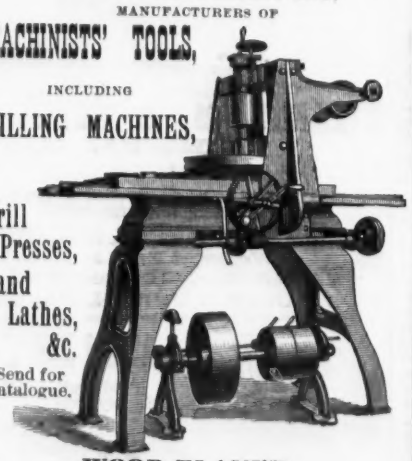

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